NUCLEAR SCIENCE ABSTRACTS

Volume 28 Number 7

Abstracts 15176-17836

October 15, 1973

UNITED STATES ATOMIC ENERGY COMMISSION

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Volume 28, Number 7, October 15, 1973

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Technical Information Center, Robert L. Shannon, Manager.

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

DIENSTBIER, Z., Effect of para-aminomethylbenzoic acid on the post-irradiation disturbance of haemocoagulation in dogs after whole-body exposure to 600 R, 27:20122
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DIETZEL, H., HEOS 2 and HELIOS micrometeoroid experiments, 27:20588

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ACCELERATOR FACILITIES/DESIGN
  Design of a neutron therapy facility for a 30-inch cyclotron, 27:25413
ACETONE/RADIOLYSIS
  Pulse radiolysis of alkyl ketones, 27:24388
  Radiothermoluminescence of aliphatic ketones (Gamma radiation), 27:24389
AEROSOL GENERATORS/OPERATION
  Operating characteristics of two compressed air nebulizers used in inhalation experiments, 27:24522 (LF--45)

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21102 (ORNL-4846) GAMMA-RAY PRODUCTION DUE TO NEUTRON INTERACTIONS WITH COPPER FOR INCIDENT NEUTRON ENERGIES BETWEEN 1.0 AND 20 MeV: TABULATED DIFFERENTIAL CROSS SECTIONS. Dickens, J. K.; Love, T. A.; Morgan, G. L. **(Oak Ridge National Lab., Tenn).** Feb 1973. Contract W-7405-eng-26. 44p. Dep. NTIS $4.00.

is indexed as:

OAK RIDGE NATIONAL LAB., TENN.
  Gamma-ray production due to neutron interactions with copper for incident neutron energies between 1.0 and 20 MeV: tabulated differential cross sections, 27:21102 (ORNL-4846)

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Public availability of all U. S. Atomic Energy Commission reports is indicated in the report number indexes. The availability of other reports, when known, is also indicated. The availability of some unnumbered reports is given in the abstract.

Dissertations from *Dissertation Abstracts International, Part B* that are included in *Nuclear Science Abstracts* are available from University Microfilms, Inc., 315 N. First Street, Ann Arbor, Michigan 48103.

Information on the availability of the published literature and unpublished conference papers abstracted in *Nuclear Science Abstracts* can be obtained from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

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Use of funds for printing this publication approved by the Director of the Office of Management and Budget, June 19, 1972.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical and Separations Chemistry

Refer also to abstracts 15474, 15501, 15972, 17463, 17705, and 17789.

15176 (ANL-8014) EIGHTEENTH ANNUAL CONFERENCE ON BIOASSAY, ENVIRONMENTAL, AND ANALYTICAL CHEMISTRY, OAK BROOK TERRACE, ILLINOIS, OCTOBER 10-11, 1972. Program and Abstracts. (Argonne National Lab., Ill.). 1972. Contract W-31-109-eng-38. 39p. (CONF-721096-). Dep. NTIS $4.00.

Abstracts of 25 papers presented at the 18th Annual Conference on Bioassay, Environmental, and Analytical Chemistry are presented. (DHM)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 15467 and 15502.

15177 (CEA-CONF-2247) TRACE ANALYSIS USING ION ABRASION TECHNIQUES AND NUCLEAR REACTIONS. Bruel, M.; Ligeon, E. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1972. 11p. (In French). (CONF-720990-5). Dep. NTIS (U. S. Sales Only) $3.00.

From conference on the physico-chemical and electrical characteristics of the material and the manufacturing procedures in the field of semiconductors; Grenoble, France (27 Sep 1972).

A method using ion abrasion techniques in conjunction with nuclear reaction microanalysis is described. The system enabled direct measurements to be made of the concentration profiles using abrasion-counting as well as providing information about the distribution of impurities on the surface of samples. The principles of these measurements are given and the experimental equipment is described, particular attention being given to the ion abrasion device. The impurity profiles of boron in silicon and zinc telluride and phosphorus in silicon were revealed. (France)

15178 (SLA-73-637) NEUTRON ACTIVATION ANALYSIS: TABULATION OF CROSS SECTIONS, Q-VALUES, DECAY CHARACTERISTICS, AND SENSITIVITIES. Kenna, B. T.; Harrison, P. E. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 89p. Dep. NTIS $6.50.

Tabulations are given for thermal activation analysis in a reactor operated in either a steady state or pulsed mode and for the accelerator produced 14 MeV neutron reactions, (n,2n), (n,p), (n,α), and (n,γ). This compilation gives target and product isotopes by chemical symbol and mass number, percentage abundance of the isotopes, the mass of the target isotope in amu (based on $^{12}C = 12.000000$), reaction cross sections, half-life, decay characteristics, Q-values, and an indication of sensitivities. (auth)

15179 REVIEW OF METHODS OF DETERMINATION OF OXYGEN IN COPPER. Navratil, V. Chem. Listy; 67: No. 5, 481-492(May 1973). (In Czech).

The most important methods of oxygen determination in copper are reviewed from the point of view of their practical utilization in analytical laboratories. An isotope method and activation analyses are considered. More attention is devoted to the method of vacuum extraction which enables a sufficient accuracy and sensitivity in the determination of very low concentration of oxygen in metallic materials (approx. 1 ppm). The values of parameters are given on the correct choice of which the accuracy of oxygen determination in copper depends. (JGB)

15180 NEW METHOD OF DETERMINING THE ISOTOPIC CONTENT OF HYDROGEN AND HELIUM IN THIN SAMPLES. Artemov, K. P.; Gol'dberg, V. Z.; Petrov, I. N.; Rudakov, V. P.; Serikov, I. N.; Timofeev, V. A. At. Energ. (USSR); 34: No. 4, 265-270(Apr 1973). (In Russian).

A new method of determining the isotopic content of hydrogen and helium in thin samples is proposed and experimentally verified. The method consists in the irradiation of a given sample by a beam of accelerated protons or alpha particles and registration by the method of coincidence of an elastic scattered particle and a recoil nucleus. The measurement results are presented in the form of a spectrum of coincidences in coordinates of total energy of coincidence particles. A sensitivity of the order of 10^{-4} at. % is easily achieved. Estimates indicate that the sensitivity can be increased to $10^{-5} - 10^{-6}$ at. %. One of the main advantages of the method is the possibility of investigating the distribution of a given isotope throughout the thickness of the sample. An analysis accuracy to within several microns can be achieved. The requirement that the samples be thin (≤ 100 microns) is not a basic limitation of the method, but depends rather on the available energy of accelerated beam. (auth)

15181 SIMPLE FACILITY FOR TOTAL BODY IN VIVO ACTIVATION ANALYSIS. Boddy, K.; Holloway, I.; Elliott, A. (Scottish Research Reactor Centre, East Kilbride, Scotland). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 428-430(Jul 1973).

The practical considerations in establishing a new facility for clinical total body in vivo neutron activation analysis when major equipment is not available are considered and a fresh approach to the technique is outlined. A preliminary assessment of the performance of the facility is given. With a shadow-shield scanning type of whole-body monitor using sodium iodide detectors and with 14 MeV incident neutrons, Ca, P, Na, Cl, and N can be measured simultaneously. With this facility it was found that there was little discomfort or trauma to the patient, operation was simple, and that the preliminary performance compared very favorably with existing much more costly techniques. (UK)

15182 ACTIVATION ANALYSIS IN POWER TECHNOLOGY. Lukens, H. R. Power Eng.; 77: No. 7, 36-38(Jul 1973).

Examples of the use of neutron activation (NAA) for the multielement analyses of coal and crude oils are given. In nuclear fields NAA is used to measure with speed and accuracy the uranium loading of fuel sticks. The method, which is outlined, can also be used to measure less than a billionth of a gram of fissile material in waste materials, including soil, water, filter papers from air monitors, urine, etc. Future developments are projected. (JGG)

15183 ANALYTICAL APPARATUS BASED ON (α,n) REACTIONS. Use for Oxygen-18 Assay. Rosenstein, A. W. (Yeda Research and Development Co., Ltd., Rehovot, Israel); Nir, A. Anal. Chem.; 45: No. 9, 1707-1710(Aug 1973).

An apparatus intended mainly for the assay of ^{18}O in chemical compounds and based on the (α,n) reaction is described. The α emitter chosen is ^{227}Ac. Examples of the use of the apparatus are given and, in the case of $H_2{}^{18}O$, the results were found comparable to those obtained by mass spectrometry. Results indicate capability of fast, simple, nondestructive assay, not requiring sample preparation, thus enabling on-line operation. The high sensitivity of mass spectrometry cannot be obtained. Possible ways of improvement of analytical precision are indicated. Other light elements can also be determined. (auth)

15184 LARGE-SCALE STUDY OF PAPER BY NEUTRON-ACTIVATION ANALYSIS. Schlesinger, H. L.; Settle, D. M. (Gulf Energy and Environmental Systems Co., San Diego, CA). J. Forensic Sci.; 16: No. 3, 309-330(1971).

A report is presented of work undertaken to ascertain which elements are detectable in paper by nondestructive thermal-neutron activation analysis, and of the levels found in the various specimens of white bond paper examined. For each sample, a 50-mg portion was irradiated for 1 min. in a flux of $\simeq 4.3 \times 10^{12}$ neutrons per sq. cm per sec., then transferred to a non-irradiated vial and (1 min. after the end of irradiation) counted for 1 min. with a NaI(Tl) detector and a multi-channel pulse-height analyser. Two portions (30 mg and 1 g, respectively) were irradiated together for 2 hr. in a neutron flux of $\simeq 1.8 \times 10^{12}$ neutrons per sq. cm per sec.; these portions were then transferred to separate vials, and the smaller portion was counted after a 1-hr. delay and again after 24 hr.; the larger portion was counted on the eighth day after irradiation and, in some instances, after longer periods (up to 25 days). The results were processed by computer to prepare γ-ray spectra, to locate the energy of each major peak and calculate its area, and to calculate the amount of each element identified and the estimated precision of the analysis. Semi-logarithmic frequency distributions of the elements were also prepared by computer. Numerous spectra and histograms for Al, Ti, Ca, Mn, Na, Cl, Sc, Sb, Cr, Ta, and Zn are presented. From considerations of variability among samples from the same lot, among manufacturers and among major components (e.g., fillers and whiteners), it is concluded that it should be possible to identify the most likely source of a given sample to a fairly high degree of probability, and to compare two or more samples, by the technique used. (Anal. Abstr.)

15185 TRACE ELEMENTS IN RNA FROM BEEF HEART TISSUE. Wester, P. O. (Serafimer Hospital, Stockholm). Sci. Totel Environ.; 1: 97-103(1972).

The trace element content was determined in RNA from beef heart tissue by neutron activation and ion exchange. The elements determined were Ag, Au, As, Ba, Br, Cd, Ce, Co, Cr, Cs, Cu, Fe, Hg, La, Mo, Rb, Sc, Se, W, Zn, Sb, and Sm. (DHM)

15186 RADIATIVE NEUTRON CAPTURE ANALYSIS OF ROCKS AND ORES. Demidov, A. M.; Ivanov, V. A.; Tarykchieva, N. K. At. Energ. (USSR); 34: No. 5, 359-363(May 1973). (In Russian).

The limits of applicability of the radiative neutron capture method for the analysis of elemental composition of rocks and ores were examined. Experiments were carried out using the thermal neutron beam from the IRT-M reactor as well as isotopic sources (Po–Be and ^{252}Cf). Spectra were measured by a Ge(Li) detector having a volume of 5 cm^3 in the energy range above 4 MeV. The results of analysis of copper–nickel, mercury and rare earth ores are presented. On the basis of these measurements, an evaluation of the sensitivity of the method for determining the element content in ores and rocks is given. (auth)

15187 DETERMINATION OF THE IMPURITIES IN GRAPHITE BY NEUTRON ACTIVATION ANALYSIS. Mukhamedshina, N. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Tashkent). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1381-1383(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1099-1101(Sep 1972).

Nondestructive neutron activation analysis was used to determine impurities in graphite. The elements determined were Al, Si, Na, Mg, Mn, Cu, Fe, Cr, Sc, and Sb. Al was identified after 2 min irradiation as ^{28}Al; Mn, Cu, and Na were identified after 20 min irradiation as ^{56}Mn, ^{64}Cu, and ^{24}Na; Fe, Cr, Sc, and Sb were identified after irradiation for 30 hr as ^{51}Cr, ^{46}Sc, ^{59}Fe, and ^{124}Sb. (DHM)

15188 DETERMINATION OF TRACE ELEMENTS IN HAIR SAMPLES FROM NORMAL AND PROTEIN-DEFICIENT CHILDREN BY ACTIVATION ANALYSIS. Bowen, H. J. M. (Pusat Atom Bandung, Indonesia). Sci. Total Environ.; 1: 75-79(May 1972).

Neutron activation analysis was used to determine Br, Cl, Cu, Mn, and Na in hair samples from 40 children suffering from protein deficiency, and from 41 normal children from Indonesia. No significant differences were found between the sexes. Mean control values (mg/kg hair) with probable errors were: Br 52.5 ± 34.2; Cl 2078 ± 911; Cu 30.8 ± 11.9; Mn 2.93 ± 1.45; Na 292 ± 173. Corresponding values for protein-deficient children were: Br 87.1 ± 46.3; Cl 2964 ± 1060; Cu 42.6 ± 21.9; Mn 14.75 ± 10.66; Na 778 ± 357. The increases in Cl, Mn, and Na were significant at the 1% level, but none of them were consistent enough for diagnosis of protein deficiency in individuals. (auth)

15189 IN VIVO NEUTRON ACTIVATION ANALYSIS FOR CALCIUM IN MAN. McNeill, K. G.; Thomas, B. J.; Sturtridge, W. C.; Harrison, J. E. (Univ. of Toronto). J. Nucl. Med.; 14: No. 7, 502-506(Jul 1973).

The calcium status of volunteers and patients was measured by in vivo neutron activation analysis, using Pu–Be neutron sources to irradiate the trunk. The results of sequential measurements on 15 volunteers, five patients with osteoporosis, and one patient with osteomalacia are presented. The measurements with the human volunteers showed reproducibility was 6.4% (1 s.d.), slightly worse than that with a skeletal phantom (4.8%). The osteomalacic patients showed a dramatic change in calcium count (+77%) as a result of treatment; a large change is also shown by radiography. The osteoporotic subjects on calcium supplements showed a significant ($p < 0.002$) transient increase in calcium count of >10%, whereas the patient without calcium supplements showed decreases of up to 26% at 8 months. (auth)

15190 FEASIBILITY OF DETERMINING TOTAL-BODY CALCIUM IN ANIMALS AND HUMANS BY MEASURING ^{37}Ar IN EXPIRED AIR AFTER NEUTRON IRRADIATION. Palmer, H. E. (Battelle Pacific Northwest Labs., Richland, WA). Contract AT(45-1)-1830. J. Nucl. Med.; 14: No. 7, 522-527(Jul 1973).

The feasibility of determining total-body calcium in rats and dogs by measuring the ^{37}Ar released after fast-neutron irradiation was shown. This method is nondestructive, reproducible, and requires a low radiation dose. It appears that this method may be feasible for determining total-body calcium in humans if the ^{37}Ar excretion rate from the bone is as rapid as its excretion from dogs. (auth)

15191 DETERMINATION OF TRACE FLUORIDE ION IN CONTAMINATED WATER BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Yabe, K.; Takahashi, Y.; Sato, T. (Government Industrial Development Lab., Hokkaido, Japan). Radioisotopes (Tokyo); 22: No. 2, 59-64(Feb 1973).

The determination of trace fluorine in contaminated water was investigated by combining a concentration technique with the fast neutron activation analysis utilizing the reaction of ^{19}F(n,2n)^{18}F. An amount of 1% $AgNO_3$ solution was added to one liter of sample water to remove Cl^- as AgCl. The filtrate was dropped through a column of 5 ml Dowex-2X anion exchange resin of acetate type. The resin was washed, dried, and packed in a polyethylene capsule of 3 ml capacity. Three samples prepared in this way and one monitoring sample (CaF_2) were simultaneously irradiated by a neutron beam with the flux of $5 \times 10^9 \sim 1 \times 10^{10}$ n/sec for 20 min. They were cooled for 100 min and the radioactivity of 0.511 MeV γ-photopeak from each sample was successively counted for 10 min. Fluoride ion at the level of 1 ppM was found to be determined without any interferences due to coexistent ions in water sample by the present analytical procedure. (auth)

15192 DETERMINATION OF OXYGEN BY ACTIVATION ANALYSIS WITH 14-MeV FAST NEUTRONS. Narita, K.; Matsumura, T.; Nagata, N. (Kobe Steel, Ltd., Japan). Tetsu To Hagane; 59: No. 3, 500-507(Mar 1973). (In Japanese).

A method for the determination of oxygen in steel and other metals by the ^{16}O(n,p)^{16}N reaction with 14 MeV-neutrons was investigated. Parameters such as instrumental conditions, sample size, and interferences from other elements were evaluated and experimentally controlled. For the industrial routine analysis a preference is given to cylindrical samples of diameter 12.5 mm and thickness 10 mm. In order to ensure a reliable pneumatic transport and minimize the error in counting, tolerances on the size must be kept within ±0.2 mm as strictly as possible. Interferences by B and F on the oxygen analysis were experimentally investigated. B and F of 0.1% correspond to oxygen of 70 and 420 ppM, respectively. The long-term coefficient of variation for analysis of a given sample over a period of 10 days is 4 to 10%. The accuracy of this method was checked by comparison of the results with those of the vacuum fusion method. The agreement of the results obtained by the two methods is satisfactory. The determination of oxygen in various powder samples such as acid insoluble residue in steel and iron powder is also demonstrated with satisfactory results. (auth)

15193 MULTIELEMENT DETERMINATION IN TOBACCO LEAVES BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Yang, M. H. (National Tsing Hua Univ., Hsinchu, Taiwan); Yeh, S. J.; Lai, S. F. Radioisotopes (Tokyo); 22: No. 3, 118-123 (Mar 1973).

A neutron activation analysis for the simultaneous determination of several elements in tobacco leaves is described. The method is based on high resolution Ge(Li) spectrometry and a computerized data reduction system. By selecting a suitable irradiation–cooling–counting system, 13 elements in tobacco leaves were quantitatively determined without any chemical separation. They are Sb, As, Br, Ca, Cl, Co, Cr, Fe, La, Hg, Mn, Sc, and Zn. Most of the photopeaks employed in the analysis were found to be free of spectral interferences. The detection limits of the elements to be determined in tobacco leaves under

the present irradiation and counting conditions were evaluated. Several elements showed somewhat higher fluctuation in tobacco leaves of different origin. (auth)

15194 ACTIVATION ANALYSIS OF GEOLOGICAL SAMPLES. Kshira Sagar, T. V. S. R.; Sriramadas, A.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Sci. Cult. (Calcutta); 38: No. 12, 531-532(Dec 1972).

Thermal neutron activation and γ spectrometry were used for the analysis of geological samples. Rapid simultaneous quantitative determinations of Mn, Al, and Si present as major and minor constituents were possible. Fe could be determined at the same time if present as a macro constituent (>10%). Cu and Ba could be determined if present as macro constituents; V could be determined in trace amounts. (JGB)

15195 DETERMINATION OF SULFUR BY CHARGED PARTICLE ACTIVATION ANALYSIS. Dabney, S. A.; Swindle, D. I.; Beck, J. N.; Francis, G.; Schweikert, E. A. (Texas A and M Univ., College Station). (1972). vp.

From international conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

An analytical method is described for the determination of trace amounts of sulfur by charged particle activation analysis. The method consists of proton irradiation followed by a rapid radiochemical separation of the product nuclide, ^{34m}Cl. This procedure has been applied to a number of pure metal samples (Fe, Al) which range in sulfur content from 0.3 to 30 ppM. All analyses were repeated several times to ensure consistent results and to better evaluate experimental detection limits and systematic errors. The results indicate that sulfur determinations can be performed at a concentration of less than 1.0 ppM. Activation curves are presented for the reactions $S(d,x)^{34m}Cl$, $S(p,x)^{34m}Cl$, and the interfering reaction $^{35}Cl(p,pn)^{34m}Cl$. (FR)

15196 PAINT IDENTIFICATION BY NEUTRON ACTIVATION ANALYSIS. Adams, F.; Hoste, J. (Univ., Ghent). Forensic Sci.; 2: 29-35(Feb 1973).

Instrumental neutron activation was applied to the comparison of a small piece of paint sticking to an iron jimmying tool and a paint sample of a door and its frame. (auth)

15197 DETERMINATION OF OXYGEN IN SODIUM USING GAMMA PHOTON ACTIVATION. Nordmann, F. (CEN de Saclay, Gif-sur-Yvette, France); Engelmann, C.; Tinelli, G. Analusis; 2: No. 2, 96-105(Feb 1973). (In French).

The oxygen and sodium activation curves were determined between 25 and 60 MeV. The detection sensitivity of oxygen is given as a function of energy. It is demonstrated that this element is only determinable in sodium for irradiation energies of less than 40 MeV. Various internal calibration possibilities are considered. The chemical separation procedures for determining oxygen (in dissolved or hydrolyzable form), or for estimating the proportion of oxygen in carbonate form after irradiation are described. The results of various analyses are given, some of which are compared to the values obtained by amalgamation. The lowest content found was 0.3 μg/g. (FR)

15198 ACTIVATION ANALYSIS OF ZIRCONIUM, ZIRCALOY, AND NICKEL-BASE ALLOY FOR TANTALUM USING EXTRACTION CHROMATOGRAPHY. Yonezawa, C.; Tamura, N.; Onishi, H. (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 22: No. 4, 437-443(Apr 1973). (In Japanese).

Extraction-chromatographic separation of ^{182}Ta from ^{95}Zr, ^{95}Nb, ^{51}Cr, and ^{60}Co was performed using methyl isobutyl ketone (MIBK) sorbed on polytrifluoromonochloroethylene (Daiflon) particles as a stationary phase and 1 N hydrofluoric and 2 N hydrochloric acid as a mobile phase. The separation method was used for the determination of tantalum in zirconium, Zircaloy, and nickel-base alloy by neutron activation using ^{182}Ta ($T_{\frac{1}{2}}$ = 115.1 days) produced by the reaction ^{181}Ta (n,γ) ^{182}Ta. The recoveries of ^{182}Ta were more than 97%, and no correction for chemical yield was necessary. Retention of other nuclides on the column is indicated. Only cerium was appreciably retained. Nuclides produced from zirconium, Zircaloy, and nickel-base alloy did not interfere with the determination of tantalum. (auth)

15199 WEAR OF ENGLISH MONUMENTAL BRASSES CAUSED BY BRASS RUBBING. Yates, J. T. Jr.; Mady, T. E.; Rook, H. L. (National Bureau of Standards, Boulder, CO). Nature (London); 243: No. 5407, 422-424(15 Jun 1973).

An investigation was undertaken to determine whether repeated brass rubbing over long periods, particularly by visitors to churches, will result in significant wear caused by friction of the brass rubbing paper. The application of neutron activation analysis to this problem is described, employing the reaction $^{63}Cu(n,\gamma)^{64}Cu$. The radiation counter was a Li-drifted Ge detector and the amount of activity caused by ^{64}Cu decay was monitored during paper sample counting times of 2 to 5 min. Results are shown tabulated and discussed. It was estimated that after 100 years the wear associated with rubbings may amount to $\sim 1.8 \times 10^{-3}$ cm, a trivial amount. The results should not be interpreted, however, as indicating that monumental brass degradation from all possible causes added together is necessarily trivial. (UK)

15200 URANIUM AND THORIUM IN ACHONDRITES. Morgan, J. W. (Univ. of Chicago); Lovering, J. F. Geochim. Cosmochim. Acta; 37: No. 7, 1697-1707(Jul 1973).

The abundances of U and Th in 19 achondrites and two pallasite olivines were measured by radiochemical neutron activation analysis. Brecciated eucrites are enriched relative to chondrites in both elements by factors between 10 and 20, perhaps as a result of a magnetic differentiation process. Two unbrecciated eucrites are far less enriched, possibly due to their origin as igneous cumulates. The diogenites Johnstown and Shalka contain approximately chondritic levels of U and Th, but Ellemeet is 10 times lower. The abundances in three howardites are in good agreement with those expected from major element data for a mixing model with eucrite and diogenite end members. The high ^{18}O basaltic achondrites Nakhla, Shergotty, and Angra dos Reis have a range of U and Th abundances similar to the brecciated eucrites and howardites, but have systematically higher Th/U ratios. The Bishopville aubrite has U and Th abundances and Th/U ratios similar to those of several enstatite chondrites, suggesting a genetic relationship. The Norton County aubrite has a low Th/U, similar to that observed in recrystallized and metamorphosed terrestrial ultrabasic rocks, indicating a more complex history. Pallasite olivines have low U and Th contents (0.5 to 4 ppB and 1.4 to 3 ppB, respectively) similar to those in terrestrial dunites. The Goalpara ureilite has very low U (<0.6 ppB) and Th (2.7 ppB) abundance consistent with an origin from carbonaceous chondrites by partial melting. (auth)

15201 UTILIZATION OF ACTIVATION ANALYSIS IN THE SEMICONDUCTOR INDUSTRY. Examples of Applications. Lafeuille, D.; Roche, D. (CEN, Grenoble, France). Analusis; 2: No. 3, 207-214(Mar 1973). (In French).

Thermal neutron activation analysis has numerous applications in the semiconductor industry. The results obtained in the LETI (Laboratoire d'Electronique et de Technologie de l'Informatique) are presented together with results obtained in other laboratories working in the following fields: studies of the cleaning of silicon surfaces and the analysis of the products used; studies of impurities in the epitaxial layers and the oxide layer; study of impurity diffusion and implantation; determination of the characteristics of the initial material. In the case of profile measurements, a rapid comparison is made between the results obtained using radioactivation, an ionic analyzer, and nuclear reactions. (FR)

Chemical and Spectral Procedures

Refer also to abstracts 15286, 15470, and 15659.

15202 (AERE-R-7065) ESTIMATION OF HYDROXAMIC ACIDS FORMED IN TBP/OK DURING REPROCESSING. Pilbeam, A. (Atomic Energy Research Establishment, Harwell (England)). May 1973. 13p. Dep. NTIS (U. S. Sales Only) $3.00. UK 50 pence.

A sensitive and rapid spectrophotometric method for determination of hydroxamic acids by solvent extraction of vanadium was investigated for application to irradiated TBP/OK nuclear fuel reprocessing solvents. A limit of detection of 5×10^{-6} M was achieved compared with 10^{-4} M by the usual iron III method. Zirconium in 20 to 100 fold excess, uranium at ca. 75% saturation of the solvent, and exposure of the solvent to 150 kJ/l (41.6 Wh/l) did not interfere with the determination of laurohydroxamic acid (LHA) at ca. 10^{-4} M by the vanadium method. The iron III method with LHA at 3×10^{-3} M on the other hand was subject to errors of the order of 5 to 10% under similar conditions. (auth)

15203 (CEA-R-4415) APPLICATION OF IONOMETRY TO THE DETERMINATION OF FLUORINE IN URANIUM. Hircq, B. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jul 1973. 39p. (In French). Dep. NTIS (U. S. Sales Only) $4.00.

The principle of ionometric determination of fluorine ions is described. The effects of the uranium matrix and pH value were studied. Ionometric determination methods, including extrapolation of the calibration curve, titration, and differential ionometry are examined. The applicability of the different methods are discussed together with the accuracies obtainable. (auth)

15204 (CONF-730807-2) TRACE IMPURITIES IN FUELS BY ISOTOPE DILUTION MASS SPECTROMETRY. Carter, J. A.; Walker, R. L.; Sites, J. R. (Oak Ridge National Lab., Tenn.). 1973. 13p. Dep. NTIS $3.00.

The use of spark source and thermal emission mass spectrometry for determining the fate of trace elements (including U) in coal fired central power plants was explored. Isotope dilution methods for the determination of Pb, Cd, and Hg in gasoline and other petroleum fuels were developed and used for referee and evaluation purposes. (DHM)

15205 ATOMIC ABSORPTION SPECTROMETRY IN ANALYSIS OF METALLIC MATERIAL. Janousek, I. (Inst of Nuclear Physics, Plzen, Czech.). Chem. Listy; 67: No. 5, 465-480 (May 1973). (In Czech).

The most important examples of utilization of atomic absorption spectroscopy in the analysis of metals and alloys are reviewed. Among the metals included are Mo, Nb, Ru, Sr, Te, Zr, and U. (205 references.) (JGB)

15206 ISOTOPIC ANALYSIS OF TRITIATED WATER. Gentry, C.; Reversat, G. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Anal. Chem.; 45: No. 9, 1710-1715(Aug 1973).

Isotopic analysis of mixtures of $H_2O-HDO-HTO-D_2O-DTO-T_2O$ can be carried out to a satisfactory approximation by infrared spectrophotometry, based on the measurement of two independent ratios such as $[DTO]/[T_2O]$ and $[HDO]/[D_2O]$. This method, which precludes any absolute measurements, has the advantage of eliminating a certain number of experimental errors. The calculation procedure is based on statistical theory and uses approximated values of the equilibrium constants. Experimental results are cross checked by comparison with microcalorimetry. (auth)

15207 SPECTROMETRIC PROPERTIES AND ANALYTICAL APPLICATIONS OF PREMIXED OXYGEN-HYDROGEN FLAMES. Mossholder, N. V.; Fassel, V. A.; Kniseley, R. N. (Ames Lab., Iowa). Anal. Chem.; 45: No. 9, 1614-1626(Aug. 1973).

Observations on 14 different elements including Sr, indicate that, in spite of its high maximum temperature (2950°K), the premixed oxygen-hydrogen flame offers few advantages as an atomization cell for flame atomic absorption spectrometry. Powers of detection are inferior to those determined in the fuel-rich nitrous oxide-acetylene flame, and serious solute vaporization interferences are observed in the relatively cool, very fuel-rich flame required for maximal dissociation of even moderately stable metal monoxides. The equivalency of emission detection limits for several elements in the oxygen-hydrogen and nitrous oxide-acetylene flames is attributable to the low spectral noise level of the former flame in most regions of the spectrum. Degrees of metal monoxide formation, calculated for Na, Fe, Be, and Ti using a thermodynamic flame model, explain the experimental results and illustrate that even when solute vaporization is complete, elements that form very stable monoxides cannot be appreciably atomized in the premixed oxygen-hydrogen flame. (auth)

15208 MOLECULAR AND ATOMIC ABSORPTION SPECTROMETRIC METHODS FOR THE DETERMINATION OF CERIUM UTILIZING THE FORMATION OF MOLYBDOCEROPHOSPHORIC ACID. Johnson, H. N.; Kirkbright, G. F.; Whitehouse, R. J. (Imperial Coll of Science and Tech., London). Anal. Chem.; 45: No. 9, 1603-1606(Aug 1973).

The formation of the heteropoly molybdocerophosphoric acid (MCPA) complex was found to permit the determination of cerium by three methods. Cerium may be determined directly in aqueous solution by measurement of the absorbance of MCPA at 318 nm (ϵ_{318nm} = 7,300). A more selective method is described in which the excess molybdophosphoric acid (MPA) formed simultaneously is selectively extracted into chloroform-butanol, the MCPA is decomposed by heating the solution, and the liberated phosphate determined by formation of MPA and extraction into isobutyl acetate for absorbance measurement at 318 nm. Between 25 and 250 μg Ce are readily determined by this method and only those ions which suppress the formation of MCPA interfere. In the third method developed, the molybdenum of the MPA extracted into isobutyl acetate for the ultraviolet absorptiometric method is determined by atomic absorption spectrometry (AAS) at 313.2 nm in a nitrous oxide-acetylene flame. This latter method provides for the selective determination of between 40 and 400 μg, i.e., 1% absorption is produced by the presence of 0.093 μg ml^{-1} Ce in the initial aqueous solution, so that the sensitivity is several orders of magnitude greater than that attainable by direct AAS in the same flame. (auth)

15209 LATERAL DIFFUSION INTERFERENCES IN FLAME ATOMIC ABSORPTION AND EMISSION SPECTROMETRY. West, A. C.; Fassel, V. A.; Kniseley, R. N. (Ames Lab., Iowa). Anal. Chem.; 45: No. 9, 1586-1594(Aug 1973).

Enhancements of refractory metal emission and absorption by a variety of concomitants were observed in nitrous oxide-acetylene flames supported on slot burners. This study of Al, Mo, and V confirms the existence of such enhancements and attributes them predominantly to changes in the horizontal distribution of analyte free atoms or molecules across the flame profile. This redistribution, which is classified as a lateral diffusion interference, was first observed by Koirtyohann and Pickett in 1968. It increases the analyte concentration at the center of the flame and decreases it at the edges. Because the elements studied form stable monoxides, oxide formation at the edges of the flame due to entrained air obscures edge depressions accompanying the enhancements in the center of unshielded flames. The interferences were therefore observed in an argon-shielded flame and confirmed in an unshielded flame with metals forming less stable oxides. It is proposed that the concomitant delays the atomization of spray droplets or solid particles, thus shortening the time available for lateral diffusion in the flame by analyte atoms or molecules before they reach the optical path. The analyte free atoms or molecules are therefore concentrated in the center of the flame and depleted at the edges. (auth)

15210 REACTION OF MOLYBDENUM(VI) AND TUNGSTEN(VI) WITH ORGANIC REAGENTS IN NONAQUEOUS MEDIA. I. Spectrophotometric Comparison of Some Hydroxy and Azo Compounds as Reagents for Molybdenum. Ponomarev, A. A.; Agrinskaya, N. A. Tr. Novocherkassk. Politekh. Inst.; 266: 99-102(1972). (In Russian).

Of 25 compounds examined for their reactivity towards Mo in toluene medium containing trioctylamine at different acidities, the best reagents for Mo at an acidity of 0.049 M were found to be p-dimethylaminophenylfluorone (I), phenylfluorone, catechol violet, pyrogallol red, and stilbazo. I shows the greatest sensitivity for Mo, with which it forms a 1:1 complex having ϵ = 4300. Tungsten does not interfere with the determination of Mo at a ratio of Mo to W of 2:1. At an acidity of the organic phase of ≈0.06 M, the reactions of Mo with azo- and hydroxy-compounds become less sensitive. The most stable complex under these conditions is formed with Chromogen black ET-00 (C.I. Mordant Black II), the metal-to-reagent ratio being 1:1; for this complex, ϵ = 7700, and Beer's law is obeyed for up to 25 μg of Mo per ml. (Ref. Zh.)

15211 ARSENAZOKHIMDU: PHOTOMETRIC REAGENT FOR RARE-EARTH METALS. Islamov, Sh. U.; Akhmedli, M. K.; Basargin, N. N. Tr. Novocherkassk. Politekh. Inst.; 266: 117-119(1972). (In Russian).

Arsenazokhimdu {[7-(2-arsonophenylazo)-1,8-dihydroxy-3,6-disulfo-2-naphthylmethyl]iminodiacetic acid} (I) reacts selectively with rare earth metals; the optimum pH range is 6 to 9. The maximum absorption of complexes of I with metals of the Y subgroup is at 580 nm. The ϵ values of the complexes of I with Y, Dy, Tm, and Lu at pH 6.0 and with a 5-fold excess of metal ions are, respectively, 11,000, 10,700, 11,200, and 11,000. Beer's law is obeyed for 0.4 to 4.0 μg of a rare earth metal per ml. Lithium, Zn, Bi, Cr III, Cd, Hg II, $Mo_7O_{24}^{6-}$ and WO_4^{2-} do not give color reactions with I; Cu, Al, Zr, Hf, Ti, Sc, and In give only low-sensitivity, low-contrast reactions. Pronounced color reactions with I are obtained with Th (at pH 2.0), Yb (pH 6.0), and Be, La, and VO_2^{3+} (pH 4.5 to 5.0). The absorption of I does not interfere in the pH range 1 to 8. (Ref. Zh.)

15212 PHYSICO-CHEMICAL PARAMETERS OF CESIUM SOLUTIONS AND THE INTENSITY OF RADIATION OF CESIUM ATOMS IN A FLAME. Bukreev, Yu. F.; Barsukov, V. I.; Grigor'ev, V. F. Tr. Tambov. Inst. Khim. Mashinostr.; No. 8, 116-124(1972). (In Russian).

The effects of HNO_3, HCl, H_2SO_4, and H_3PO_4 at concentrations up to 4 N, and of V_2O_5 at concentrations up to 6 g/l, on the intensity of Cs atomic emission at 862.1 nm in a propane-butane-air flame were studied. The presence of acids in the test solution reduces the radiation intensity of Cs: e.g., an increase in HNO_3 concentrations up to 4 N reduces the intensity by 33 to 38%. It is shown that the intensity depends on the conditions of atomization of the test solution and on the processes taking place in the flame, and that the maximum amount of V that does not affect the determination of Cs can be calculated. (Ref. Zh.)

15213 APPLICATION OF HEATING OF THE [ATOMISER] CHAMBER AND THE BODY OF THE BURNER IN EMISSION AND ATOMIC ABSORPTION FLAME PHOTOMETRY [OF SODIUM, STRONTIUM, AND COPPER]. Zolotavin, V. L.; Barsukov, V. I.;

Bukreev, Yu. F. Tr. Tambov, Inst. Khim. Mashinostr.; No. 8, 105-111(1972). (In Russian).

The effect of heating the chamber of the atomizer to 200°C on the sensitivity of the determination of Na, Sr, and Cu in an air–propane–butane flame was studied. The sensitivity of the determination of Na and Sr by emission flame photometry is improved 8 to 10-fold by such heating, and the sensitivity of the determination of Cu by atomic absorption is improved 5 to 8-fold. (Ref. Zh.)

15214 PHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH ORGANIC DYES. Sokolova, L. S.; Shchemeleva, G. G. Tr. Novocherkassk. Politekh. Inst.; 266: 10-13(1972). (In Russian).

Acid chrome violet K [C. I. Mordant Violet 5 (I)] is proposed as reagent for Zr, with which it forms a 1:1 complex in 0.5 N HCl medium. The ϵ value is 5500, and Beer's law is obeyed with 5 to 40 μg of Zr in 25 ml. To the test solution add 2 N HCl to give a total acidity of 0.5 N, then add 1 ml of 0.03% I solution in H_2O–acetone (1:1) and dilute the solution to 25 ml with H_2O. Measure the extinction at 560 nm against a reagent blank. Large amounts of Re, Sc, PB(II), Cd, Th, Cu(II), Zn, Ge, and Ni are tolerated. A comparison of I with catechol violet, picramine R, and chlorsulfophenol S (II) showed that the reaction of Zr with II is the most sensitive, and that with I is the most selective. (Ref. Zh.)

15215 EFFECT OF EXTRACTION CONDITIONS ON THE REACTION OF ZIRCONIUM WITH ORGANIC REAGENTS IN HYDROCHLORIC ACID MEDIA CONTAINING TRIBUTYL PHOSPHATE. I. Kir'Yanova, N. A.; Kovalenko, E. V.; Davydova, R. T. Tr. Novocherkassk. Politekh. Inst.; 266: 113-117(1972). (In Russian).

The reactions of Zr with 65 organic reagents were investigated. Eriochrome black T (I) and magneson IREA (II) form stable complexes with Zr, which can be extracted into a mixture of tributyl phosphate (III) with an aromatic hydrocarbon or halogenated hydrocarbon from 5.67 N HCl medium. These complexes are almost colorless in pure III, but show a distinct color if the III is diluted with benzene, and also, for the II complex, if the III is diluted with dichloroethane. The extinction of the extracts is stable for several days. (Ref. Zh.)

15216 THERMOMETRIC TITRATION OF SOME MOLYBDATES, MOLYBDIC ACID, AND MOLYBDENUM TRIOXIDE. Kiba, N.; Takeuchi, T. (Nagoya Univ., Japan). Anal. Chim. Acta; 66: No. 1, 75-84(Aug 1973).

A thermometric titrator equipped with differential thermistor is used for the titration of molybdenum in sodium molybdate, potassium molybdate, magnesium molybdate, tetramethylammonium molybdate, and tetraethylammonium molybdate, based on their reactions with hydrochloric acid, and in ammonium paramolybdate, molybdic acid, and molybdenum trioxide, based on their reactions with sodium hydroxide. Orthomolybdates and ammonium paramolybdate were determined in the 0.5 to 0.005 M range; sufficient solid molybdic acid or molybdenum trioxide was taken to give a final 0.01 to 0.5 M solution in 20 ml of water. The method is simple and very quick. The standard deviation varies from 0.5 to 1.5% depending on the amount of sample taken. (auth)

15217 PYRAZYL METHYL KETONES AS POTENTIAL CHELATING AGENTS. Guyon, J. C.; Maurits, W. J. (Memphis State Univ.). Mikrochim. Acta; No. 3, 413-416(1973).

A series of 2-pyrazylmethyl ketones was prepared by the acylation of 2-pyrazylmethylsodium with the esters of various carboxylic acids. The methyl, ethyl, iso-propyl, tert-butyl, and phenyl ketones were prepared. The analytical utility of the 2-pyrazylmethyl ketones was systematically investigated and potentially useful interactions with a number of divalent metal ions and Mo^{6+} were observed. (auth)

15218 DETERMINATION OF CHROMIUM, VANADIUM, IRON, AND MOLYBDENUM BY THE METHOD OF EPR AFTER THEIR PRIOR CONVERSION TO A PARAMAGNETIC STATE. Gushchin, B. M. (Inst. of Chemistry, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 16: No. 5, 45-48(1973). (In Russian).

Methods were developed for reducing Cr(VI) to Cr(I), V in ammonium vanadate to V(IV), and Fe(II) to Fe(I), all with hydroxylamine sulfate, and Mo(VI) to Mo(V), $[MoOCl_5]^{2-}$ by boiling with hydrazine chloride. These conversions became the basis for an EPR determination of these elements in their paramagnetic state. (KSW)

15219 CHEMICAL-SPECTRAL DETERMINATION OF TRACES OF RARE EARTH IMPURITIES IN RARE-EARTH BASES. Shmanenkova, G. I.; Zemskova, M. G.; Melamed, Sh. G.; Pleshakova, G. P. (State Scientific-Research and Planning Inst. of the Rare Metals Industry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1370-1374(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1088-1093(Sep 1972).

The column parameters and experimental conditions for extractive–chromatographic isolation of rare earth impurities from terbium, dysprosium, and ytterbium were determined. The extractant used was bis(2-ethylhexyl) phosphate, and the extractant carrier was hydrophobized large-pore silica gel (type KSK). The rare earth impurities were separated during elution with hydrochloric acid solution at 40°C. The content of individual rare earths in the impurity concentrates was determined spectrally. Two methods were used to record the spectra: vaporization of the concentrate and a filler from the pit of a charcoal electrode in an arc flame and vaporization of the concentrate without a filler from a thin film formed by evaporation of a drop of solution containing the rare earth impurities on the face of a charcoal electrode. (DHM)

15220 IODOMETRIC DETERMINATION OF SELENIUM AND TELLURIUM WHEN THEY ARE PRESENT SIMULTANEOUSLY. Zakharov, V. A.; Songina, O. A.; Klyueva, R. I. (Kazakh State Univ., USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1344-1345(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1066-1067(Sep 1972).

An iodometric method for determining selenium and tellurium is described that is based on the different reactivity of iodine with respect to elementary tellurium and selenium in bicarbonate medium. Under these conditions elementary tellurium is rapidly and quantitatively oxidized by free iodine, while elementary selenium practically does not react with iodine; therefore, the sum of selenium and tellurium can be determined by titration of the iodine liberated in acid medium, while only selenium is determined in bicarbonate medium. The amount of tellurium can be found by difference. (DHM)

15221 REACTION OF PRASEODYMIUM WITH HYDROXYETHYLIDENEDIPHOSPHONIC ACID. Kirillov, A. I.; Turkina, L. A.; Blasov, N. A. (Irkutsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 16: No. 6, 846-849(1973). (In Russian).

Hydroxyethylidenediphosphonic acid (HEDPA) has been used as an eluent in the cation exchange separation of rare earth elements. The direct determination of Pr in a solution of HEDPA using absorption spectra techniques was investigated. A complex 2HEDPA · Pr formed at pH 10 which permitted the assay of Pr spectrophotometrically in the presence of members of the Y subgroup. The sensitivity of the method was 1 μg/ml, the accuracy 8.0%, with a determination time of 15 min. (KSW)

15222 IN-LINE GAS ANALYZER FOR UF_6 AND F_2 THROUGH DIFFERENTIAL THERMAL CONDUCTIVITY MEASUREMENTS. Tsujino, T.; Sugikawa, S.; Miyajima, K. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 118-124(Feb 1973).

For the purpose of analyzing UF_6 and F_2 continuously in the fluorination of U, a system of differential thermal conductivity cells (TCC), equipped with shock absorber, and also NaF and KCl traps, was constructed. Mixed flow-through/diffusion type katharometers are used, provided with four and two Ni filaments (~30 Ω) on the UF_6 and F_2 cells, respectively. Based on data obtained from preliminary operating tests, the standard conditions for operating the system were established, i.e., 500 mmHg abs. Cell pressure, 200 ml/min flow rate and 80 mA bridge current. Under these operating conditions and for UF_6 and F_2 concentrations of 2 and 20% respectively, the overall output variations are below 1%. The total response time of the system including the transport lag is below 1 and 2.5 min for UF_6 and F_2 cells, respectively. The dead time due to blow-back noise is observed to have about the same period as the above response time. The sensitivities for UF_6 and F_2 are found respectively to be 11.5 and 0.37 mV/%, for which the limits of analytical determination are 0.01 and 0.05%, respectively. By practical application to uranium fluorination, the TCC system thus devised, has proven to possess the requisite characteristics for measurements of reaction rate, fluorine utilization and end of reaction in fluid-bed fluorination of uranium oxides. The system has possibilities of application to the study of reaction steps. (auth)

15223 COLLABORATIVE STUDY OF THE MICROANALYTICAL DETERMINATION OF IODINE BY OXYGEN FLASK COMBUSTION. Lalancette, R. A.; Steyermark, A; Lukaszewski, M.; Kostrzewski, P. L. (Rutgers–The State Univ., Newark, NJ). J. Ass. Offic. Anal. Chem.; 56: No. 4, 888-891(Jul 1973).

Twenty-two collaborators participated in the study of a specific method using oxygen flask combustion followed by mercurimetric titration of the resulting iodide. With the exception of 2 collaborators, all obtained acceptable results on *m*-iodobenzoic acid. Statistical evaluation of the data from all collaborators gave:

$\bar{\bar{x}}$ = 51.07%, $\bar{x}$ = theory = –0.10% $\bar{s}$ = 0.28, and S_m = 0.94. When the results of 2 collaborators are omitted, the corresponding values are: 51.07%, –0.10%, 0.15, and 0.19, respectively. Similar results were obtained on p-nitroiodobenzene. The results from all collaborators gave: $\bar{\bar{x}}$ = 50.82%, $\bar{x}$ = theory = –0.14%, $\bar{s}$ = 0.19, and S_m = 0.43. When the results of 3 collaborators are omitted, the values are: 50.87% –0.09%, 0.14, and 0.23, respectively. The method has been adopted as official first action, as an alternative to the Carius method, for the determination of iodine in organic compounds. (auth)

15224 SPECTRAL DETERMINATION OF RARE EARTH COMPONENTS OF FERROELECTRIC AND PIEZOELECTRIC CERAMIC MATERIALS. Fadeeva, L. A.; Karpenko, L. I. Zh. Prikl. Spektrosk.; 18: No. 5, 763-767(May 1973). (In Russian).

An investigation of the oxygen-containing compounds of rare earth elements and some elements of Groups II and IV (Ti, Zr, Pb, and Ba) showed that their chemical composition exerted an important effect on the absolute and relative intensities of lines of the alloying rare earth components. Calibration graphs are given for more accurate determination of La, Ce, Nd, Eu in the oxides (0.05 to 0.5%) Ln_2O_3, and in chemical compounds containing Ti, Zr, Pb, Ba or in solid solutions based on these compounds. (KSW)

15225 ANALYSIS OF TRITIATED WATER. Reversat, G.; Le Clainche, C. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Bull. Inform. Sci. Tech. (Paris); No. 178, 47-50(Feb 1973). (In French).

Isotopic analysis of mixtures of light water, heavy water, and tritiated water was carried out by infrared spectrophotometry. The anionic impurities, hydrogen peroxide, nitrates, and nitrites were determined by molecular spectrophotometry and the metallic impurities by optical spectrography. (FR)

15226 METHOD OF DETERMINING AVAILABLE MOLYBDENUM IN CALCAREOUS SOIL. Dekhkankhodzhayeva, S. Kh.; Kruglova, E. K. (Inst. of Soil Science, Tashkent). Sov. Soil Sci. (Engl. Transl.); 4: No. 2, 247-251(1972).

Translated from Agrokhimiya; No. 4, 109-113(1972).

A comparative evaluation of several extractants used to determine Mo revealed quantitatively similar results. The Mo dissolution curves are similar and they correlate both with the amount of Mo added to the soil and with the amount in cotton. It is recommended that the final determination of Mo be made with α-benzoinoxime (by the Bol'shakov–Stoilov polarographic method). (auth)

15227 DETERMINATION OF COPPER AND ZINC IN BIOLOGICAL MATERIALS. A Comparison of Atomic Absorption with Spectrophotometry and Neutron Activation. Smeyers-Verbeke, J.; Massart, D. L. (Vrije Univ., Brussels). Clin. Chim. Acta; 44: 243-248(1973).

A comparison is made between atomic absorption spectroscopy, neutron activation analysis and spectrophotometric methods for the determination of Cu and Zn in brain and serum. The results of direct determinations for atomic absorption are compared with those obtained by standard addition. (auth)

15228 EFFECTS OF CETYLPYRIDINIUM CHLORIDE AND ZEPHIRAMINE ON SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM(VI) WITH GALLEIN. Sakuraba, S. (Aomori Prefecture Industrial Research Inst., Hirosaki, Japan). Jap. Anal.; 22: No. 3, 270-275(Mar 1973). (In Japanese).

Gallein reacts with molybdenum(VI) in the presence of cetylpyridinium chloride (CPC) to form a water soluble, red-purple chelate. The absorption maximum was at 590 nm, and the absorbance was constant over the pH range from 1.0 to 2.7 adjusted with HCl buffer solution. The complex has a composition of 1:1.5 in the excessive CPC. The molar absorptivity is 4.9×10^4 at 590 nm and the sensitivity is 0.0020 μg Mo/ml for an absorbance of 0.001. The effect of diverse ion on the absorbance of the complex was examined. Antimony, tin, vanadium, and tungsten must be avoided. Antimony could be masked by an addition of 0.05M EDTA. Vanadium could be masked by an addition of 0.05M EDTA and 0.1 g KF. The ternary complex system between molybdenum(VI), gallein and zephiramine formed a water soluble blue chelate. The absorption maximum was at 620 nm, and the absorbance was constant over the pH range from 1.0 to 1.5 adjusted with buffer solution. The complex has a composition of 1:2 in the excessive zephiramine. The molar absorptivity is 5.2×10^4 at 620 nm and sensitivity is 0.00185 μg Mo/ml for an absorbance of 0.001. The effect of diverse ions on the absorbance of the complexes was examined. Tin, chromium, titanium, and silver must be avoided. Both complexes were proposed for the spectrophotometric determination of microgram amounts of molybdenum. The calibration curve at 590 nm (in the presence of CPC), and at 620 nm (in the presence of zephiramine) was quite linear for 0 to 3.5 μg/ml molybdenum. (auth)

15229 MICROANALYTICAL DETERMINATION OF DEUTERIUM IN ORGANIC COMPOUNDS. Fraisse, D.; Girard, D.; Levy, R. (CNRS, Thiais, France). Talanta; 20: No. 7, 667-680(Jul 1973). (In French).

A simple method is described for the microdetermination of deuterium in organic compounds. It involves a flash combustion of the weighed sample in a hot empty changer at 950 to 1050° and swept by oxygen at 60 ml/min. Together with this combustion in the gaseous phase, an oxidation of the primary combustion gases on cupric oxide at 850° is necessary. Oxidation products containing halogens and sulfur are retained on silvered alumina at 750 to 800°. Combustion water containing deuterium oxide and hydroxide is frozen out from the combustion gases in a special trap with two five-way stopcocks that make possible the simultaneous flow of oxygen and hydrogen; the latter is used as a carrier-gas in the apparatus from the trap downwards. The frozen water is then vaporized by heating in a hydrogen flow of 30 ml/min and reduced on magnesium at 600°. Deuterium is obtained as deuterium hydride in hydrogen; it is measured versus pure hydrogen, with a thermal conductivity detector. A determination within a series can be completed in 15 min. The precision of the results is that obtained in classical organic microanalysis. (auth)

15230 BAKEABLE VALVE BODY FOR CALIBRATION BY ISOTOPIC DILUTION OF VERY SMALL QUANTITIES OF GAS. Pagani, A.; Donville, B. Vide; No. 162, 249-253(1972). (In French).

An ultrahigh-vacuum apparatus for pipetting of very small amounts of gases (~10^{-7} cc NTP) is described. It is possible with this apparatus to store the gas in two tanks of different volumes (0.709 cc and 7.51 cc); calibration of the corresponding amounts of gases by isotopic dilution can also be performed. The methods of volume calibration are described, and tests specifying the working conditions of such an apparatus are given. (auth)

15231 KINETIC METHOD FOR DETERMINATION OF MOLYBDENUM(VI) IN TAP WATER. Klyachko, Yu. A.; Petukhova, N. M. (All-Union Correspondence Inst. of the Food Industry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 8, 1163-1164(Aug 1972).

Translated from Zavod. Lab.; 38: No. 8, 921-922(Aug 1972).

A method is described for determining Mo(VI) in tap water based on the molybdenum-catalyzed oxidation of hydroquinone by iodate ion in acidic medium in the presence of potassium oxalate. A linear relation between the reaction rate and the molybdenum concentration is observed at concentrations between 1×10^{-4} and 1×10^{-3} μg/ml. (DHM)

Radiometric and Radiochemical Procedures

Refer also to abstracts 15536, 15647, 15656, 15824, and 15835.

15232 (AECL-4365) METHOD FOR THE DETERMINATION OF STRONTIUM-90 AND CESIUM-137 IN RIVER SEDIMENTS AND SOILS. Grummitt, W. E.; Lahaie, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1973. 15p. Dep. NTIS (U. S. Sales Only) $3.00. AECL $0.50.

A method for the simultaneous determination of strontium-90 and cesium-137 in soil and silt is outlined. The method involves four main steps: ashing of the soil or silt to remove organic material, fuming with HF to remove silica, fusing with alkali to separate Cs from Sr, thereby increasing the solubility, and finally β counting. The nuclides can be measured by this procedure in amounts as low as 0.1 picocurie per 100 grams. Chemical yield normally varies from 65 to 80 percent of the radioactivity present in the sample, so that for cesium-137 the method is appreciably more sensitive than gamma spectrometry. (auth)

15233 (NIM-1514) DETERMINATION BY X-RAY-FLUORESCENCE SPECTROMETRY OF MINOR AMOUNTS OF NIOBIUM AND TANTALUM IN GEOLOGICAL MATERIALS. Domel, G.; Russell, B. G. (National Inst. for Metallurgy, Johannesburg (South Africa)). 18 Apr 1973. 13p. Dep. NTIS (U. S. Sales Only) $3.00.

The development of a method having a lower level of determination of 0.01% of the oxide is described. Mineralogical effects are eliminated by fusion of the material with nine times its mass of a flux comprising lithium tetraborate, calcium fluoride, and lanthanum oxide; the melt is pressed into a glass disc. Residual matrix effects are corrected by the background-ratio technique, the intensity measurements being evaluated against synthetic calibration standards. The method has been successfully tested on synthetic pegmatite samples of known composition, a coefficient of variation of less than 1.4% being obtained when the concentra-

tion of oxide was 0.5%. Possible interferences are discussed, and the effect of the presence of uranium and thorium is assessed quantitatively. (auth)

15234 (UCRL-51388) ELEMENTAL ANALYSIS OF AIR FILTER SAMPLES USING X-RAY FLUORESCENCE. Bonner, N. A.; Bazan, F.; Camp, D. C. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Jun 1973. Contract W-7405-eng-48. 50p. Dep. NTIS $5.45.

An x-ray fluorescence system was designed for elemental analyses of air filter samples. It consists of radioisotope exciters, a Si(Li) detector and a computer based pulse height analyzer. It is capable of making qualitative measurements of all elements heavier than phosphorus (Z = 15) and quantitative measurements of all elements heavier than potassium (Z = 19). For samples on Whatman 41 filter paper and fluoresced for 1000 sec, the three sigma detection limits range from 10 to 100 ng/cm^2. These correspond to 3 to 30 ng/m^3 of air for typical 24-hr collections with HiVol samplers. Accuracy of the system is within ±10% and reproducibility is better than 5%. The method requires no sample preparation and is completely nondestructive. Quantitative information obtained with such a system can be useful in monitoring trace element concentrations in air, hence in providing data for the formulation and enforcement of air quality standards. (auth)

15235 IDENTIFICATION OF RADIOACTIVE ISOTOPES IN REACTOR POOL WATER. Mancuso, R. V.; Ulinski, J. A. (Department of Physics, State University of New York College at Brockport, Brockport, New York, 14420). Am. J. Phys. 41: No. 3, 405-409 (Mar 1973).

A lithium-drifted germanium detector has been used to identify 36 radioactive isotopes in a sample of pool water from the Western New York Research Center reactor. A total of 100 peaks were observed in gamma-ray spectra taken over a period of 3 months. The primary methods of production of the isotopes are fission and the (n,γ) reaction. Two isotopes were produced by the (n,p) reaction and possibly one by the (p,n) reaction. Fission products are present in the water as a result of a fuel element cladding failure. The elements which were activated are either in the water as a result of corrosion of material in the pool, or in water soluble compounds of elements from material in the pool. (auth)

15236 OBSERVATION OF MUONIC X-RAYS FROM BONE. Taylor, M. C.; Coulson, L.; Philips, G. C. (Rice Univ., Houston, TX). Radiat. Res.; 54: No. 3, 335-342(Jun 1973).

The muonic x-ray, which results from the capture of a negative muon into orbit around a nucleus to form a "muonic atom," may be a useful diagnostic probe. The x-ray transition energies are about 200 times the energies from electronic transitions; the carbon Kα energy is of the order of 75 keV. Thus, muonic x-rays from light elements have considerable penetrating power and can escape from bulky media. Experimental results for negative muons stopped in bone are presented to demonstrate the potential of the technique for observing elements in the range from carbon to calcium in biological specimens. Advantages and disadvantages of this technique with respect to other methods of elemental analysis are discussed. (auth)

15237 SOME SIMPLE AND QUICK METHODS FOR THE DETERMINATION OF RADIOACTIVE CONTAMINATION OF THE SEA WITH ^{90}Sr AND ^{137}Cs. Bauman, A.; Juras, M. Kem. Ind.; 20: No. 6, 265-271(1971).

A method is described for precipitation of ^{90}Sr with oxalate, where calcium is used as a non-isotopic carrier. Cs-137 is recovered from the sea by a batch method using ammonium phosphomolybdate (AMP) ion exchange crystals. Another method for a quick separation of ^{137}Cs from the sea using Na-triphenylcyanoborate (NaTPCB) was developed. The chemical yield can be determined gravimetrically. (auth)

15238 IDENTIFICATION OF REACTION PRODUCTS FORMED ON IRRADIATED AUSTENITIC STEEL SURFACES BY ELECTRON PROBE MICROANALYSIS AND γ-RAY SPECTROMETRY. Hilton, D. A.; Robins, L. H. (Central Electricity Generating Board, Berkeley, Eng.). J. Iron Steel Inst. (London); 211: No. 6, 440-443(Jun 1973).

From conference on developments in physical methods of chemical analysis and microanalysis of metals; Zurich, Switzerland (26 Sep 1972).

The 20% Cr–25% Ni–Nb-stabilized austenitic steel which is used as a clad for the uranium dioxide fuel in advanced gas-cooled reactors is subjected to different environments during irradiation. The outer surface of the steel undergoes oxidation due to exposure to the carbon dioxide coolant while, at the surface in contact with the fuel, reaction products are sometimes observed which contain fission products. High-resolution γ-ray spectrometry and electron probe microanalysis are used as complementary techniques to identify the products from these reactions. The γ-ray spectrum provides data on the radioactive nuclides present and is of particular use in identifying fission products, neutron-activated impurities, and the non-adherent oxide particles which are released from the outer surface of the steel to the coolant. The results obtained by electron probe microanalysis show the distribution of the constituents in the reaction products which, in conjunction with the γ-ray spectral data, facilitates the interpretation of the mechanisms involved. The relevance of these techniques in relation to an assessment of the performance of the steel is briefly discussed and their importance in identifying areas where further fundamental studies are required is demonstrated. (auth)

15239 GAMMA-SPECTROMETRIC MEASUREMENTS OF CLARKEITES OF RADIOACTIVE ELEMENTS IN GOLD ORE FIELDS IN A SHALE BELT. Balykin, P. A.; Borob'ev, V. I.; Krendelev, F. P. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 209: No. 1, 190-192(1 Mar 1973). (In Russian).

The U, Th, and ^{40}K contents in gold-bearing ores were analyzed spectrometrically. Quartz veins possessed a lower natural radioactive content; highest radioactive contents were correlated with altered shales in exocontact veins. Regions of maximum dispersion of the radioactive content and of the Au coincided, but not in all cases. (KSW)

15240 X-RAY RADIOMETRIC FLUORESCENCE ANALYSIS OF LEAD IN LEAD–BARIUM MINERALS AND THEIR BY-PRODUCTS USING A ^{109}Cd RADIOISOTOPE SOURCE. Betin, Yu. P.; Krampit, I. A. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 8, 1208-1210(Aug 1972).

Translated from Zavod. Lab.; 38: No. 8, 957-959(Aug 1972).

A modification of the x-ray radiometric fluorescence method for the analysis of lead in lead–barium minerals and their by-products is proposed that utilizes the L series characteristic radiation that is excited by a ^{109}Cd radioisotope source. By using the L series rather than the K-series radiation for the determination of lead in minerals the measurements can be carried out using wide beams in conjunction with a low activity ^{109}Cd radioisotope source (0.5 to 5.0 mCi). (DHM)

15241 HEAVY ELEMENTS IN SURFACE MATERIALS: DETERMINATION BY ALPHA PARTICLE SCATTERING. Economou, T. E.; Anderson, W. A.; Blume, E. M. (Univ. of Chicago). Science; 181: No. 4095, 156-158(13 Jul 1973).

The backscattering of alpha particles from a radioactive source can be used to determine the amounts of heavy elements such as lead in surface materials. A light, portable instrument has been constructed that can be used as a survey meter for painted surfaces. It has a sensitivity of 0.3 percent by weight in a measurement of a few minutes. (auth)

15242 ANALYSIS OF RADIOACTIVE PRODUCTS BY SPARK MASS SPECTROMETRY. Billon, J. P. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Analusis; 2: No. 2, 137-140(Feb 1973). (In French).

The modifications made to a spark mass spectrometer in order to analyse impurities in ^{239}Pu enriched plutonium are indicated. The contamination risks involved are examined together with the preventive measures necessary. The validity of the results is discussed. (FR)

15243 VARIOUS METHODS FOR THE QUANTITATIVE ANALYSIS OF GASEOUS TRITIUM. Schott, R. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Bull. Inform. Sci. Tech. (Paris); No. 178, 19-26(Feb 1973). (In French).

The following methods are available for determining tritium gas: ionization chamber counting, gas chromatography, mass spectrometry. Gas chromatography is also used to determine gaseous impurities in tritium. (FR)

15244 CHEMICAL IDENTIFICATION AND ACCURATE MEASUREMENT OF TRITIUM IN GASEOUS MEDIA. Dupuis, M.; Dupuis, M. C.; Charrier, G.; Colomer, J.; Humbert-Droz, C.; Lutz, M. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Bull. Inform. Sci. Tech. (Paris); No. 178, 27-45(Feb 1973). (In French).

Several techniques were developed for the identification and accurate measurement of tritium in gas samples. For specific activities ranging from 10^{-6} Ci/m^3 to a few Ci/m^3, tritium in volatile form (hydrogen or light hydrocarbon) can be identified and measured by gas radiochromatography. For lower activities up to 10^{-12} Ci/m^3, the following methods must be used: concentration (distillation, preparative gas phase chromatography, purification on uranium) of the samples in the form of tritiated compounds (water, hydrogen, hydrocarbons); low-level measure-

ments (liquid scintillation, ionization chamber, or proportional counter measurements). (FR)

15245 ANALYSIS OF LITHIUM DEUTERIOTRITIDE. Lefevre, H.; Reversat, G.; Putaux, J. C. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). Bull. Inform. Sci. Tech. (Paris); No. 178, 51-54(Feb 1973). (In French).

The conditions for the analysis of lithium deuteriotritides are studied. It is possible to determine (H, D, T, and Li) and the principal impurities (C, N, and O) with only a few milligrams of product. Such analyses must be carried out in a glove box. (FR)

15246 IMPROVED PYROLYTIC DIGESTION METHOD FOR THE DETERMINATION OF RADIOSTRONTIUM IN REACTOR GRAPHITE. May, K.; Stoeppler, M. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem.; 264: No. 3, 177-180(1973). (In German).

An improved method for the rapid oxidizing digestion of reactor graphite pellets, granulate, or dust and charcoal together with strontium carrier in oxygen at about 900°C is described. Digestion is carried out in a very simple quartz and Pyrex apparatus. The sample ash with carrier is dissolved for the necessary decontamination procedures in HCl. Samples up to about 1 g could be analyzed with radiostrontium losses lower than 5%. (GE)

15247 URANIUM DISTRIBUTIONS IN RECENT SKELETAL CARBONATES. Schroeder, J. H.; Miller, D. S.; Friedman, G. M. (Rensselaer Polytechnic Inst., Troy, NY). J. Sediment. Petrol.; 40: No. 2, 672-681(Jun 1970). (COO-3462-5).

Fission-track analysis, which was used to map uranium distributions in sections at the ppB to ppM level, revealed considerable intraskeletal heterogeneities in corals and mollusks. In the corals studied a zone next to the internal surface of the corallite uranium is enriched with respect to the inner portions of the skeleton; configuration and the factor of relative enrichment of this zone vary between different coral species. The branching coral Oculina diffusa, in addition, exhibits alternating bands of relatively high and low uranium contents arranged subparallel to the external surface. In the mollusk shells studied, uranium concentrations vary between different layers of a given shell; further variations exist within a given layer perpendicular to the direction of accretion. These systematic heterogeneities result from variations in the processes of skeleton formation and growth. In all samples, variations which appear to be random were observed; they are superimposed on any distributional pattern that may exist. The heterogeneities found indicate that compositional complexities similar to those known from the major elements in skeletal carbonates exist on the trace element level. Trace element distribution in carbonate skeletons is determined primarily by biological processes and can be expected to change when affected by physicochemical diagenetic influences. Hence, the patterns of uranium distribution presented in this study are potential indicators of uranium mobility during diagenesis and potential checks on the closed system requirement for uranium series dating of biogenic carbonates. (auth)

15248 ANALYSIS BY X-RAY FLUORESCENCE: NATURE OF THE BACKGROUND CONTINUUM AROUND AN X-RAY FLUORESCENCE EMISSION LINE; APPLICATION TO ELIMINATING THE VARIOUS ERRORS ARISING IN THE DETERMINATION OF SMALL QUANTITIES OF Hf IN ZIRCONIUM OXIDES. Vie Le Sage, R. (Univ., Paris); Grubis, B. Compt. Rend., Ser. C; 276: No. 9, 759-762(26 Feb 1973). (In French).

Complete analysis of the background continuum and the accurate determinations carried out enabled the measurements to be considered independently of physical differences due to the preparation of the samples and variations in the primary excitation. (FR)

15249 DETERMINATION OF ^{210}Po IN CIGARETS AND TOBACCO. Lopes dos Santos, P.; Weinberg, E. M.; Penna Franca, E. (Inst. of Biophysics, Rio de Janeiro). Rev. Biol. Med. Nucl.; 2: No. 2-3, 73-77(1970). (In Portuguese).

The content of ^{210}Po was determined in various tobacco products, including cigarettes, cigars, and pipe tobacco of different brands manufactured in Brazil. The average content of Brazilian cigarettes is about the same as the values found in the United States, Argentina, India, and Pakistan, above the ones observed in Indonesia, Turkey, and Greece and below the ones found in Rhodesia, Australia, and Central American countries. (auth)

Separation Procedures

Refer also to abstract 15393.

15250 (INIS-mf-336) ACTIVATION ANALYSIS OF VANADIUM IN OIL. Maestrini, A. A. (Minas Gerais Univ., Belo Horizonte (Brazil). Instituto de Pesquisas Radioativas). [nd]. 9p. (In Portuguese). INIS.

A new method for the determination of vanadium in petroleum by activation analysis is presented. Vanadium content is determined in the ppM range in a very short irradiation time. (INIS)

15251 SYSTEMATIC STUDY OF THE EXTRACTION OF METALS USING N-BENZOYL-N-PHENYLHYDROXYLAMINE. Riedel, A. (Technical Univ. of Prague). J. Radioanal. Chem.; 13: No. 1, 125-134(Jan 1973).

The extraction of Y, La, Ce(III), Gd, Th, Fe(III), Co(II), Cu, Zn, Cd, Hg, In, and Tl (I = 0.1; T = 20 ± 2°C) with N-benzoyl-N-phenylhydroxylamine (N-BPHA) in chloroform was studied in order to determine the composition, and the extraction and two-phase stability constants of the extracted chelates. The dissociation constant of N-BPHA in aqueous solution was also determined. (auth)

15252 METHOD FOR THE CONTINUOUS SEPARATION OF PLUTONIUM FROM URANIUM IN THE TWO-PHASE SYSTEM BY MEANS OF ELECTROLYTIC REDUCTION. Schwind, E.; Schlosser, P. (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,730,851. 1 May 1973. Priority Date 5 Feb 1969, Federal Republic of Germany (F.R. Germany). 6p.

A method is presented for separating uranium compounds and plutonium compounds by liquid–liquid extraction. Plutonium is reduced to the trivalent stage by electrolytic reduction, during the extraction process in a region of thorough mixing of aqueous and organic phase, and because of the difference in distribution coefficients is separated together with the aqueous phase. (Official Gazette)

15253 PROCESS FOR SEPARATION OF HAFNIUM FROM ZIRCONIUM. Larsen, E. M.; Gil-Arnao, F. C. (to Wisconsin Alumni Research Foundation). U. S. Patent 3,734,689. 22 May 1973. Filed Date 7 Feb 1969. 8p.

A process is reported for separating hafnium from zirconium wherein the tetrahalides of the metals are reacted with either aluminum or zirconium in finely divided form in the presence of an aluminum trihalide at a reaction temperature above the melting point temperature for the aluminum trihalide. The reaction is carried out in a liquid system with preferential reduction of the zirconium component over the hafnium component to enable separations between the two elements. (Official Gazette)

15254 SOLVENT EXTRACTION OF PLATINUM-GROUP METALS AND GOLD WITH 2-MERCAPTOBENZOTHIAZOLE. Diamantatos, A. (Minerals Processing Research Lab., Knights, South Africa). Anal. Chim. Acta; 66: No. 1, 147-151(Aug 1973).

The application of 2-mercaptobenzothiazole to the solvent extraction of all Pt-group metals and gold is described using chloroform as solvent. The following topics were considered: extraction of Pd from HCl and alkaline solution as well as its separation from Pt; extraction of Au from HCl; the extraction of Pt after heating and extraction of Pt with 2-mercaptobenzothiazole and tin(II) chloride; extraction of Rh after heating, extraction of Rh with 2-mercaptobenzothiazole and tin(II) chloride, and its separation from Ir; and the extraction of Ru after heating and its separation from Os. (DHM)

15255 RE-EXTRACTION OF SCANDIUM FROM BIS(2-ETHYLHEXYL)PHOSPHATE BY SODIUM FLUORIDE. Koshul'ko, L. P. Tr. Kaz. Politekh. Inst.; No. 33, 258(1971). (In Russian).

X-ray and optical studies were used to assess the use of solid NaF for the re-extraction of Sc from bis(2-ethylhexyl)phosphoric acid solutions. This organic acid is valuable for concentrating Sc from low grade technical solutions, but there is a disadvantage because of some loss of Sc when HF and NaOH are used for the re-extraction. Solid NaF gives Na hexafluoroscandiate which is precipitated. Re-extraction of 93 to 95% of the Sc is possible using a 3 to 5 times NaF excess during this process. (Metals Abstracts)

15256 CHROMATOGRAPHIC SEPARATION OF NIOBIUM FROM TITANIUM, TUNGSTEN, MOLYBDENUM, AND VANADIUM ON THE FLUOROFORM OF THE AB-16 ANION EXCHANGER. Gudushauri, Ts. N.; Brouchek, F. I. (Georgian Polytechnic Inst., Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 70: No. 3, 609-612(Jun 1972). (In Russian).

Techniques of chromatographic separation of Nb–Ti, Nb–W, Nb–Mo, Nb–V, and Ti–V–W–Nb mixtures on fluoroform of the AB-16 anion are described. The techniques were tested using model mixtures and niobium-containing alloys. (auth)

15257 POSSIBLE APPLICATION OF THE EDTA FORM OF ANIONITES FOR THE SEPARATION OF URANYL IONS. Brouchek, F. I.; Berishvili, L. A. Tr. Gruz. Politekh. Inst.; 1: No. 149, 40-44(1972). (In Russian).

The sorption of UO_2^{2+} in the presence of Be^{2+}, Fe^{3+}, and Al^{3+} on

AV-17 anionite (EDTA form) was studied. The Be^{2+}, Fe^{3+}, and Al^{3+} are eluted as their EDTA complexes, leaving the UO_2^{2+} on the column and thereby effecting separation of UO_2^{2+} from the other ions. The extent of sorption decreases in the order UO_2^{2+}, Fe^{3+}, Al^{3+}, Be^{2+}. (Ref. zh.)

15258 CHOICE OF OPERATION PARAMETERS OF ION-EXCHANGE COLUMNS FOR SEPARATIONS OF HIGHLY RADIOACTIVE NUCLIDES. Schuetz, B. O.; Specht, S.; Born, H. J. (Technische Univ., Munich). Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). vp. (In German).

From reactor meeting; Karlsruhe, Germany (10 Apr 1973).

Influencing parameters in high-pressure ion exchange chromatography of rare earths as model substances for the transplutonium elements were studied utilizing radiotracers. (GE)

15259 COMPETITION BETWEEN NITRIC AND NITROUS ACIDS IN TRIBUTYL PHOSPHATE EXTRACTIONS. Marin, B.; Sellier, J.; Gourisse, D. J. Inorg. Nucl. Chem.; 35: No. 8, 2907-2915(Aug 1973). (In French).

The distribution coefficients of nitrous acid in the systems: TBP p%–dodecane–HNO_3–HNO_2–H_2O {[p%(v) = 15%, 20%, and 30%]} were measured. An original experimental method avoiding nitrous acid decomposition was used. A statistical treatment of the results has shown that the variations of distribution coefficients of nitrous acid versus free (non-complexed) TBP concentrations are explained by simple calculations. (auth)

15260 PREPARATION AND SOME PROPERTIES OF CHROMIUM PHOSPHATE ION EXCHANGER. Akiyama, T.; Tomita, I. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 35: No. 8, 2971-2983(Aug 1973).

Two types of chromium phosphate ion exchanger were prepared. One has low affinities for multivalent metal ions, the other has high affinities. Distribution coefficients and their temperature dependence were measured for Na^+, K^+, Rb^+, Cs^+, Mg^{2+}, Ca^{2+}, Ba^{2+}, Co^{2+}, Zn^{2+} and Ce^{3+} ions. Ion-exchange capacities and thermostability in water were also examined. The pH titration curves show that these exchangers are polyfunctional for Na^+ and Cs^+, but behave monofunctionally for Ba^{2+}. The ion-exchange properties are strongly influenced by preparation conditions, e.g., mixing ratio of the materials, drying conditions, storage conditions and heating conditions. (auth)

15261 EFFECT OF THE SOLVENT ON EXTRACTION OF EUROPIUM AND THULIUM BY DI-2-ETHYLHEXYL AND DI-N-BUTYL PHOSPHORIC ACIDS. Zikovsky, L. (Ecole Polytechnique, Montreal). J. Inorg. Nucl. Chem.; 35: No. 8, 2917-2922 (Aug 1973).

The extraction of europium (Eu) and thulium (Tm) into a solution of bis(2-ethylhexyl) (DEHP) or di-n-butyl (DBP) phosphate in various solvents was investigated as a function of DEHP or DBP concentrations in the organic phase and HNO_3 concentrations in the aqueous phase. Distribution ratios D were measured radiometrically. A plot of log D vs log $[H^+]$ or log C is well represented by straight lines of slopes –3 and 3. These data indicate that complexes of the type $MA_3(HA)_3$ (M = Eu or Tm, HA = DEHP or DBP) are formed. The extraction is enhanced by the solvent in the order: heptane, cyclohexane, butyl ether, carbon tetrachloride, toluene, xylene, nitrobenzene, bromoform, chlorobenzene, hexone, dichloromethane, chloroform. (auth)

15262 SEPARATION OF MOLYBDATE, PERTECHNATE, IODATE, IODIDE, AND RUTHENATE IONS USING THIN-LAYER CHROMATOGRAPHY. Makie, Y. (Industrial Research Inst. of Kanagawa Prefecture, Yokohama, Japan); Murakami, Y. Nippon Kagaku Kaishi; 1973: No. 1, 85-90(Jan 1973). (In Japanese).

When fission products are separated by means of cation exchange chromatographic method, cations contained in the fission products are adsorbed on the resin, while anions such as MoO_4^{2-}, TcO_4^-, IO_3^-, I^- and RuO_4^{2-} are passed through the resin column. In order to separate and purify those eluted anions in alkaline aqueous solution, a thin layer chromatographic (TLC) method was used. Alumina adsorbent containing 5% gypsum was investigated for the purpose, and three kinds of developing systems were studied; (1) acetone–NH_4OH, (2) methanol–NH_4OH, and (3) water–NH_4OH mixture. It was found that the best developing solution for separation of the anions was the mixture of water and NH_4OH of any ratio, and that the R_f value of them were 0.55 for MoO_4^{2-}, 0.82 for TcO_4^-, 0.30 for IO_3^-, 0.92 for I^- and 0.00 for RuO_4^{2-}. In studying the behavior of these anions in the developing system, it was observed that RuO_4^{2-} was reduced to ruthenium dioxide and remained at origin on the plate, while the migration of TcO_4^- and I^- were caused by the water in developing solution. The behaviors of MoO_4^{2-} and IO_3^- were studied as follows: the thin layer plate spotted with MoO_4^{2-} and IO_3^- were confined in the vessel saturated with NH_3 vapor to let it adsorb the NH_3 vapor, the development was carried out with water alone. Similar result was obtained with the case of water and NH_4OH mixture development. Furthermore, the relationship between R_f value of MoO_4^{2-} and IO_3^- with the amount of adsorbed NH_3 and adsorbing time were investigated. R_f values of these anions increased with the amount of NH_3, which was adsorbed very rapidly on the alumina and reached the maximum within about 3 seconds. From this result, it was found that NH_3 plays an important role for the behavior of MoO_4^{2-} and IO_3^-. (auth)

15263 EXTRACTION OF NIOBIUM AND TANTALUM FROM COLUMBITE BY THE NITROFLUOR PROCESS. Kigoshi, A.; Okada, K.; Ohmi, M. (Tohoku Univ., Sendai). Sci. Rep. Res. Inst., Tohoku Univ., Ser. A; 24: No. 3, 97-105(Jan 1973).

The nitrofluor process provides a thorough method of dissolving the columbite in a nonaqueous inorganic solvent, purifying the niobium and tantalum, and separating them by volatile separation techniques. Hydrofluoric acid solutions of N_2O_3, N_2O_4 or NOF can disintegrate the columbite even at room temperature. Subsequently, most of the niobium and tantalum precipitate as complex fluorides, leaving in the solution relatively large quantities of impurities, such as iron, manganese, titanium, and tin. For further isolation of the complex fluorides of niobium and tantalum from the impurities, a volatilization of the niobium and tantalum from the dissolver solid separated from the dissolver solution was found effective. There appears to be a possibility of separating niobium and tantalum from each other by fractional sublimation utilizing the difference of volatility of these complex fluorides when the HF–N_2O_3 azeotrope is used for disintegrating the columbite. A general flowsheet for treating typical columbite or tantalite by the nitrofluor process is proposed. (auth)

15264 SOLVENT EXTRACTION OF TRIVALENT ACTINIDES AND LANTHANIDES FROM A MIXTURE OF CARBOXYLIC AND AMINOPOLYACETIC ACIDS. Fardy, J. J.; Pearson, J. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Inorg. Nucl. Chem.; 35: No. 7, 2513-2514 (Jul 1973).

The purity of di(2-ethylhexyl)phosphoric acid (HDEHP) markedly influenced the separation of cerium from americium in a lactic acid solution containing diethylenetriaminepentaacetic acid (DTPA) but had little influence on separations involving the least extractable rare earths, europium and promethium. Synergism occurred in the solvent extraction of these elements by mixtures of thenoyltrifluoroacetone (HTTA) and neutral organophosphates (S) from the same aqueous medium. This effect decreased as S was changed from a phosphine oxide, through phosphonate, to the neutral alkyl phosphates. Tracer studies showed that the composition of each extracting species is given by the general formula $M(TTA)_3S_2$ where M is a trivalent actinide or lanthanide. These species were independent of the diluent used but the extraction coefficients of the metal ions decreased by a factor of 10^4 from cyclohexane to chloroform. At a constant pH the extraction of americium and cerium was inversely proportional to DTPA concentration in the region 10^{-3} to 10^{-1} M. At lower DTPA concentrations the cerium dependence decreased rapidly while the americium increased until at 10^{-4}M concentration of DTPA the extraction order was reversed. When the DTPA concentration was constant the separation of cerium from americium increased with increasing pH, reaching a constant maximum at pH 2.6 and above. (auth)

Inorganic, Organic, and Physical Chemistry

Chemical and Physicochemical Properties

Refer also to abstracts 15259, 15380, 15385, 15386, 15413, 15511, 15917, 15918, 15924, 16054, 17724, and 17725.

15265 (BARC-655) WATER CHEMISTRY STUDIES. XI. pH Maintenance in Nuclear Reactor Water Systems: A Comparative Assessment. Venkateswaran, G.; Prasad, S. S.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1973. 29p. Dep. NTIS (U. S. Sales Only) $3.50.

The advantages and disadvantages of the commonly used pH controlling materials in the primary and secondary coolant systems are reviewed. Primary system pH control which bristles with difficulties, calls for a greater understanding of all salient features of the reagents to be used. LiOH which undisputedly ranks superior to all other alkalis has a potential challenger from NH_4OH. No happy compromise can be struck between the two. These two have inherent advantages and disadvantages and no final verdict can be given in favor of either. LiOH in resin

form enjoys unchallenged supremacy. As far as the secondary system is concerned the two commonly used reagents, namely morpholine and cyclohexylamine have nearly identical behaviors and beneficial effects. Pure phosphate alkalinity is a very desirable objective in internal boiler-water treatment. (auth)

15266 (CONF-730701-1) CHEMISTRY AND THERMODYNAMICS OF MOLTEN SALT REACTOR FUELS. Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). 1973. 38p. Dep. NTIS $4.00.

From United States–Japanese seminar on thermodynamics and phase relations of nuclear materials; Ames, Iowa, USA (9 Jul 1973).

Generalizations about the chemistry and thermodynamics of MSBR fuel solutions are considered and the equilibrium measurements and thermochemical data are used to consider how the state of oxidation (the redox potential) and the oxide content of the fuel determine the chemical behavior of the structural metals, the actinide, and the fission product elements. Advantages and disadvantages of the MSBR concept are summarized. (DHM)

15267 (ORNL-4832, pp 37-61) PART 2. CHEMISTRY. Grimes, W. R. Mar 1973. Molten-Salt Reactor Program Semiannual Progress Report for Period Ending August 31, 1972.

Research progress is reported on chemical problems posed in the design and operation of molten-salt reactor systems. Study of permeation of metals by hydrogen isotopes seems to have demonstrated conclusively that the rate of permeation for "clean" metals depends on the square root of the hydrogen partial pressure. Significant uptake of tritium by graphite at elevated temperatures was confirmed. Solubilities of hydrogen, deuterium, and helium in Li_2BeF_4 are tabulated. Solubilities of BF_3 in molten fluoride solvents, $LiF-BeF_2-ThF_4$, are also tabulated. Progress is reported on studies on the stability and volatility of metal tellurides and the effects of tellurium vapor on metals. Progress is also reported on analytical studies, which include in-line chemical analysis of molten fluoride salt streams, voltammetric studies of protonated species in molten $NaBF_4-NaF$, ir spectral studies of $NaBF_4-NaF$, studies of protons in molten $NaBF_4$, analysis of coolant cover gas, and spectral studies of molten salts. (JGB)

15268 OBSERVATIONS ON THE REACTION LAYER OF LiOH ON LiH. Holcombe, C. E.; Powell, G. L. (Union Carbide Corp., Oak Ridge, TN). J. Nucl. Mater.; 47: No. 1, 121-124(May 1973).

Scanning electron microscopic and x-ray diffraction observations are reported for LiOH films grown on the {100} planes of LiH single crystals. The crystals were first exposed to water vapor or room air for 6 months, and then portions were vacuum annealed at 75 or 200°C for 2 weeks. Results indicated the presence of LiH, LiOH, a trace of $LiOH \cdot H_2O$, and Li_2CO_3. The vacuum anneal at 75°C produced only microcracking of the LiH side, while that at 200°C resulted in the spalling apart of the three regions, with some Li_2O in the Litt region. An estimate is made of the average strain between the LiOH and LiH. It is concluded that the rate-controlling step of the $H_2O-LiOH-LiH$ reaction occurs at the LiOH/LiH interface. (DLC)

15269 TEMPERATURE EFFECTS ON RADIATIVE AND RADIATIONLESS TRANSITIONS OF Gd^{3+} IN SOLUTION. Haas, Yehuda; Stein, Gabriel; Würzberg, Elhanan (Department of Physical Chemistry, The Hebrew University, Jerusalem, Israel). J. Chem. Phys. 58: No. 7, 2777-2780 (1 Apr 1973).

Temperature effects on the fluorescence of Gd^{3+} in H_2O solution are presented and discussed. The quantum yield does not approach unity near the freezing point. In the case of Gd^{3+}, high energy vibrations of single solvent molecules do not quench the fluorescence. The results are interpreted by use of the "junction" mechanism involving the ion and solvation shell [Y. Haas and G. Stein, J. Phys. Chem. 76, 1093 (1972)] and by clarifying the role of the levels giving rise to a broad band in both absorption and emission in solution. (auth)

15270 KINETICS OF THE ELECTROREDUCTION OF TRIVALENT LANTHANIDE IONS. II. La, Ce, Pr, Sm, Eu, Dy, and Yb. Almagro, V.; Almagro, J.; Sancho, J. (Junta de Energia Nuclear, Madrid). An. Quim.; 69: No. 2, 185-188(Feb 1973). (In Spanish).

As an addition to the study on the electrochemical kinetics of the reaction $M^{+3} + 3e = M^0$, corresponding to the trivalent lanthanide ions in the dropping mercury electrode data are presented about equilibrium potential E_0, reaction rate constant, k_0, and electron transfer constant, α, for La, Ce, Pr, Sm, Eu, Dy, and Yb. The new results obtained are in agreement with the previous ones, and special emphasis is placed on the possible influence in the results when ethanol and gelatine are present in the solution. (auth)

15271 MECHANISM OF REACTION OF ZrO_2 WITH CARBON AT HIGH TEMPERATURES. Pavlov, Yu. A.; Manukhin, A. V.; Melekhin, V. F. (Moscow Inst. of Steel and Alloys). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 46-49(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 51-55(Jan 1973).

Under the experimental conditions of this investigation, at 2000 to 3000°K dissociation of ZrO_2 to ZrO and atomic oxygen is thermodynamically possible. A mechanism is proposed for the reaction of ZrO_2 with solid carbon at high temperatures. (auth)

15272 PREPARATION AND INFRARED SPECTROSCOPIC CHARACTERIZATION OF SOME (OXYDIACETATO)URANYL(6) COMPLEXES. Bor, G. (Consiglio Nazionale delle Richerche, Padua); Magon, L.; Maresca, L.; Natile, G. J. Chem. Soc., Dalton Trans.; No. 12, 1308-1311(1973).

Polymeric complexes $[UO_2(oda)]_n$ (oda = oxydiacetate, $O_2CCH_2-OCH_2CO_2^{2-}$, $n = \infty$), were prepared from the reaction of uranyl(VI) ions and oxydiacetic acid or its disodium salt, and characterized, mainly by ir spectroscopy. The complex $Na_2[UO_2(oda)_2]$, nH_2O (n = 2 or 3) was obtained when an excess of the ligand was used in the reaction. In the presence of pyridine N-oxide (Opy), both monomeric $[UO_2(oda)\ (Opy)_2]$ and polymeric $[UO_2(oda)\ (Opy)]_n$ ($n = \infty$) complexes were obtained. (auth)

15273 POLAROGRAPHIC STUDIES OF SOME LANTHANOIDS(III) IN N,N-DIMETHYLACETAMIDE. Aihara, M.; Misumi, S. (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap.; 46: No. 1, 175-178(Jan 1973).

Polarographic behavior of some lanthanoids(III) was studied in N,N-dimethylacetamide. La(III), Pr(III), and Nd(III) showed irreversible, three-electron reduction wave and the other lanthanoids(III), Gd(III), Tb(III), Dy(III), Ho(III), Er(III), Tm(III), and Lu(III) except Sm(III), Eu(III), and Yb(III), gave irreversible, three-electron reduction wave with a pre-wave. The kinetic parameters for La(III), Pr(III), and Nd(III) were determined by means of Koutecky's method. Sm(III), Eu(III), and Yb(III) showed two-step reduction waves, the first wave being a reversible, one-electron reduction wave. These solvated lanthanoids(III) were investigated also by cyclic voltammetry. (auth)

15274 RATE CONSTANTS FOR THE REACTION $D+H_2=DH+H$ AT LOW TEMPERATURES USING ESR DETECTION. Mitchell, D. N.; Le Roy, D. J. (Lash Miller Chemical Laboratories, University of Toronto, Toronto 181, Ontario, Canada). J. Chem. Phys. 58: No. 8, 3449-3453 (15 Apr 1973).

The reaction $D+H_2=DH+H$ has been studied in the temperature range 167–346°K. The results, which include measurements at considerably lower temperatures than previously employed, are in good agreement at the higher temperatures with those of other workers. A slight amount of curvature is observed in the Arrhenius plot, although less than previously measured. An empirical fit to the results, which also agrees with the previous high temperature data, is $k_3 = (1.64 \pm 0.10) \times 10^7 T^2 \exp[(-5360 \pm 40)/RT]$ cc/mole. sec. (auth)

15275 THE ABSORPTION SPECTRUM OF $BkCl_3$. Carnall, W. T.; Fried, S.; Wagner, F. Jr. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). J. Chem. Phys. 58: No. 9, 3614-3624 (1 May 1973).

The absorption spectrum of thin films of $BkCl_3$ was measured in the region ~3800–48 000 cm^{-1} at 298°, 77°, and 4°K. The absence of transitions from the ground state to excited J=0 and J=1 states, together with the number of crystal field components observed in several isolated groups, suggested that the ground level $BkCl_3$ is characterized by the crystal quantum number $\mu=0$, as is the case in $LaCl_3:Tb^{3+}$. Assignments were made based in part on a predicted energy level scheme which assumed a systematic variation in energy level parameters over the actinide series. The free-ion electrostatic, spin orbit, and configuration interaction parameters for Bk^{3+} were calculated by a least squares fitting process involving 23 level assignments. (auth)

Isotope Effects

Refer also to abstracts 15790 and 16828.

15276 (COO-3498-9) FUNDAMENTAL STUDIES IN ISOTOPE CHEMISTRY. Progress Report, 1 July 1972–30 Jun 1973. Bigeleisen, J.; Harris, T. H. (Rochester Univ., N. Y.). [nd]. Contract AT(11-1)-3498. 10p. Dep. NTIS $3.00.

Progress is reported on studies on vapor pressure isotope effects and liquid–vapor fractionation factors. Experimental investigations of $^{12}C^{16}O_2-^{13}C^{16}O_2-^{12}C^{18}O_2$ were completed. Results were analyzed in terms of the statistical mechanical theory of condensed phase isotope effects. Studies of the liquid vapor isotope fractionation factor for $^{15}N^{16}O/^{14}N^{18}O$ over a wide temperature range have delineated the specific contributions of dimerization, external translation and rotation, and internal mode coupling to the large isotope separation factor in this process useful for the

production of enriched ^{15}N and ^{18}O. A large body of data (computer) has been collected relating molecular forces and isotope effects in important prototype molecules. These have led to a simplified statistical mechanical theory of end-atom isotope effects. (JGB)

15277 STUDIES ON ALKYL METAL ALKOXIDES OF ALUMINUM, GALLIUM, AND INDIUM. I. Vibrational Spectra of Dimethylaluminum Methoxide and Methylmethoxyaluminum Chloride. Mann, G.; Haaland, A.; Weidlein, J. (Univ., Stuttgart). Z. Anorg. Allg. Chem.; 398: No. 3, 231-240(Jun 1973). (In German).

The vibrational spectra (ir and Raman) of dimethylaluminum methoxide and deuteromethoxide were measured and assigned. These trimeric alkoxides consist of puckered six-membered Al_3O_3 ring skeletons probably of C_s or C_2 symmetry. The structure of methylmethoxyaluminum chloride could not be determined definitely from the spectroscopic data. (auth)

15278 RELATION BETWEEN RATE AND EQUILIBRIUM CONSTANTS FOR PROTON-TRANSFER REACTIONS. Kreevoy, M. M.; Oh, S. (Univ. of Minnesota, Minneapolis). J. Amer. Chem. Soc.; 95: No. 15, 4805-4810(25 Jul 1973).

Considerable curvature is found in the Brønsted plot for the hydrolysis of diazoacetate ion by trialkylammonium salts. This curvature can be accounted for by Marcus' theory of atom transfer. The resultant parameters serve to separate from the free energy of activation that part which must be provided before the rate-determining proton transfer can take place and is, consequently, insensitive to the spontaneity of the overall reaction. The variation of the primary hydrogen isotope effect with structure in the same reactions is successfully correlated by the same parameters. A number of other reactions, for which data are taken from the literature, seem to follow similar patterns. (auth)

15279 MEDIUM EFFECTS ON HEAVY-ATOM KINETIC ISOTOPE EFFECTS. I. Cell Model Without Internal-External Coordinate Interaction. Keller, J. H.; Yankwich, P. E. (Univ. of Illinois, Urbana). J. Amer. Chem. Soc.; 95: No. 15, 4811-4815 (25 Jul 1973).

The method of Stern, Van Hook, and Wolfsberg for the calculation of vapor pressure isotope effects was applied to model calculations of medium effects on ^{13}C kinetic isotope fractionation in the decomposition (via several reaction coordinates) of a hypothetical triatomic molecule, formic acid, and oxalic acid. Molecular parameters were given values characteristic of organic compounds, while the necessary external force constants were adjusted to yield associated frequencies typical of moderate H bonding (30 to 90 cm^{-1}). No interactions between external and internal coordinates were introduced, nor was any external coordinate included in a reaction coordinate. When the same external force field is applied to the reactant and transition states (chemically inactive medium), isotope fractionation due to the medium is small in comparison with the ordinary imprecision in kinetic isotope effect measurements. Differences in external force fields between reactant and transition states yield increments to the kinetic isotope effects proportional to the differences, but still of the size of experimental errors, in the absence of internal coordinate force constant shifts and internal–external coordinate couplings. The cell model predicts that medium-induced isotope fractionation effects will be negligible unless medium-reactant interactions are so strong that corresponding gross rate effects would be observable. (auth)

15280 HYDROGEN ISOTOPE EFFECTS IN THE REACTION OF WATER VAPOR WITH ALKALI METAL MIRRORS. Bremner, R. O.; Volman, D. H. (Univ. of California, Davis). J. Phys. Chem.; 77: No. 15, 1844-1849(19 Jul 1973).

The reaction of variable-composition-deuterated water vapor with alkali metal mirrors at 23° to yield hydrogen gas was studied. From flow experiments it was determined that every collision of water with the surface results in removal of water. In static experiments, it was found that isotope fractionation and composition of molecular hydrogen produced was independent of the metal to water ratio for metal in excess. Under these conditions, the expression $([HD]^2/[H_2][D_2]) = Q$ yielded $Q = 12.0 \pm 2.6$, well above the equilibrium constant value of 3.85 and 298°K, independent of metal. These results are in accord with the following model: the reaction of metal with water results in the corresponding alkali hydroxide and a bound hydrogen atom; these adatoms transfer by quantum mechanical tunneling for which the relative probabilities for H and D are $(P_1/P_2) = 9.9$ and the calculated transfer energy based on an assumed rectangular barrier is approximately 6.0 kJ mol^{-1}; molecular hydrogen is formed by the reaction of transfer atoms with adatoms. The order of effectiveness of the metals to yield H enrichment in the gas was Na ≅ K < Li < Rb ≅ Cs but the differences were not large. Isotope fractionation is explained by assuming fractionation occurs through HOD + M → MOD + M– –H (k_1), HOD + M → MOH + M– –D (k_2). Zero-point energy considerations yield $(k_1/k_2) = 14.0$, giving general agreement with the results. (auth)

15281 SECONDARY AND SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ELECTRONIC ABSORPTION SPECTRA OF ANILINES. Jensen, J. L.; Gardner, M. P. (California State Univ., Long Beach). J. Phys. Chem.; 77: No. 15, 1900-1904(19 Jul 1973).

The visible-ultraviolet spectra of 13 anilines were measured in H_2O and D_2O. Spectral shifts of 180 cm^{-1} for primary anilines and 40 cm^{-1} for tertiary anilines are attributed to differences in solvation by specific hydrogen bonding at the amino group. Secondary isotope effects arising from exchange of amino hydrogens for deuteriums are shown to be small, 0 to 40 cm^{-1}. In all cases, only the effects on the primary band (^1La band) are significant. These solvent isotope effects do not seem to be measurably dependent upon electrolyte concentration. (auth)

15282 INVESTIGATIONS ON HYDRATES. V. Vibrational Spectra and Thermal Decomposition of $LiBO_2 \cdot nH_2O$. Manewa, M. (Chemical-Technological Inst., Sofia); Fritz, H. P. Z. Anorg. Allg. Chem.; 397: No. 3, 290-296(Apr 1973). (In German).

The vibrational spectra and thermogravimetric data of the hydrates of $LiBO_2$ are reported and the coordination of the H_2O molecules is discussed. The water molecules of the D_2O compounds separate at slightly higher temperatures than those of the H_2O compounds. (auth)

15283 ISOTOPE EFFECT ON THE DEHYDRATION REACTION OF 2-PROPANOL ON ALUMINA AND SILICA–ALUMINA. Yamaguchi, T.; Tanabe, K. (Hokkaido Univ., Sapporo). Nippon Kagaku Kaishi; 1973: No. 2, 240-244(Mar 1973). (In Japanese).

The dehydration reactions of 2-propanol and deuterated 2-propanol (*i*-PrOH-d_8) on alumina and silica–alumina were carried out by employing a closed circulation method at 160 and 170°C and in the pressure range of 2-propanol from 5 to 18 mm Hg. The hydrogen isotope effects were obtained by analyzing the observed data by the use of a Langmuir type rate equation. In the case of alumina, the values of the primary isotope effect were found to be large (4.06 at 160°C and 3.47 at 170°C), whereas, in the case of silica–alumina, the isotope effect was certainly small, though the exact values could not be determined. It was concluded from these results that on alumina, 2-propanol is dehydrated via E2-ideal type reaction intermediates and, on silica–alumina, the dehydration reaction proceeds via E1 type reaction mechanism. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 15318.

15284 PROBABILITY METHOD FOR THE KINETIC EQUATION DERIVATION FOR ISOTOPE EXCHANGE EQUILIBRIA IN FERMENTATION REACTIONS. Knorre, D. G.; Malygin, E. G. (Inst. of Organic Chemistry, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 207: No. 6, 1391-1393(21 Dec 1972). (In Russian).

The authors had previously developed a kinetic equation (1971) which described the isotope exchange equilibria for ATP-^{32}P-pyrophosphate (enzyme-catalyzed by t-RNA-ligases). A probability method is proposed for the derivation of the kinetic equations for the same isotope exchange equilibrium which is essentially much simpler than the 1971 version. (KSW).

15285 ISOTOPE EXCHANGE IN A HETEROPHASE SYSTEM. Extraction With Subsidiary Reactions In The Aqueous Phase. Fomin, V. V. Dokl. Akad. Nauk SSSR; 207: No. 6, 1406-1408 (21 Dec 1972). (In Russian).

The term "subsidiary reactions" is here applied (in extractive processes) to slow reactions occurring in the aqueous phase that determine the extraction rate. A theoretical development is offered of the dependence of the isotopic exchange rate between phases on the velocity of the subsidiary reactions. The type reaction considered, where M* is a radioactively-labelled metal atom, is M*A + B ⇌ M*C + D, where compound M*A distributes itself very rapidly between phases, and compound M*C does not pass over into the organic phase. (KSW).

15286 SYSTEM FOR ACCURATE AND FAST MEASUREMENT OF THE GAS PHASE H/D RATIO IN ELECTROLYTIC H/D SEPARATION FACTOR EXPERIMENTS. Hammerli, M.; Olmstead, W. J. (Chalk River Nuclear Labs., Ont.). J. Appl. Electrochem.; 3: No. 1, 37-44(Feb 1973).

Accurate and fast measurements of electrolytic hydrogen–deuterium separation factors are required to study short-term time effects and the effects of other variables, for example overpotential, before the cathode has suffered irreversible changes

such as hydrogen embrittlement. A system for fast measurement of the hydrogen–deuterium ratio of the liberated hydrogen isotopes in argon as the sweep gas was developed and is described in detail. Unique features include a modified Cartesian manostat and an automatic Toepler pump in the gas collection system, and an automatic mass spectrometer inlet system whose cycle time is about 4 min. Calibration procedures are outlined. The accuracy and reproducibility in the H/D ratio are ±1% and ±0.5%, respectively, for the range 0.75 to 5.0 mol.% deuterium in mixtures containing 0 to 80 vol.% argon. (auth)

15287 APPLICATION OF MICROWAVE SPECTROSCOPY TO THE MECHANISM OF HYDROGEN–DEUTERIUM EXCHANGE IN PROPENE BY HOMOGENEOUS CATALYSTS. Tolman, C. A.; Scharpen, L. H. (Du Pont De Nemours and Co., Wilmington, DE). J. Chem. Soc., Dalton Trans.; No. 6, 584–588(1973).

Quantitative microwave analyses of $[^2H_1]$ propenes formed by deuterium exchange of propene with CH_3OD by homogeneous catalyst of platinum, rhodium, and nickel are reported. The results permit a clear choice of the metal hydride addition-elimination mechanism over the π-allyl mechanism. Secondary isotope effects in the β-elimination of MH from the intermediate 1-deuterio-2-metallo-propane are in good agreement with a calculated value of $K_H/K_D = 1.18$. The relationship of the propene results to deuterium/isomerization studies on but-1-ene is discussed. (auth)

15288 DEUTERIUM ISOTOPE EXCHANGE BETWEEN CARBOXYLIC ACIDS AND HYDROGEN. Torre, F. J.; Czuczak, M.; Monse, E. U. (Chemistry Department, Rutgers– The State University, Newark, New Jersey 07102). J. Chem. Phys. 58: No. 5, 1804-1808 (1 Mar 1973).

The catalytic exchange of deuterium between carboxylic acids and hydrogen according to $RCOOH(l)+HD(g) \rightleftharpoons RCOOD(l)+H_2(g)$, where R=H or CH_3, has been studied with the acids in the pure state at various temperatures, and in solutions of carbon tetrachloride at 25°C. The hydroxyl hydrogen of the acids is about 3–4 times more enriched in deuterium than the hydrogen gas. The measured isotope effects are discussed in terms of molecular force field calculations for formic and acetic acid. (auth)

15289 ELECTROPHILIC REACTIONS AT SINGLE BONDS. XII. Hydrogen–Deuterium Exchange, Protolysis (Deuterolysis), and Oligocondensation of Alkanes with Superacids. Olah, G. A.; Halpern, Y.; Shen, J.; Mo, Y. K. (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc.; 95: No. 15, 4960–4970(25 Jul 1973).

Twenty-one alkanes, including methane, ethane, propane, butane, 2-methylpropane, 2-methylbutane, and 2,2-dimethylpropane, were studied in FSO_3H-SbF_5 and $HF-SbF_5(SO_2ClF)$ as well as in the corresponding deuterated superacid systems. Hydrogen–deuterium exchange and protolysis, followed frequently by oligocondensation, were observed, indicating the general reactivity of C–H and C–C single bonds toward superacid systems. All data indicate frontside electrophilic attack on the involved bonds involving pentacoordinated carbonium ions. (auth)

15290 ELECTROPHILIC REACTIONS AT SINGLE BONDS. XI. Hydrogen–deuterium exchange of $H_2(D_2)$ in Superacids Involving Isomeric $(H,D)_{3+}$ Ions. Olah, G. A.; Shen, J.; Schlosberg, R. H. (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc.; 95: No. 15, 4957–4960(25 Jul 1973).

Molecular hydrogen and deuterium were found to undergo exchange reactions in superacids at room temperature, as indicated by HD formation. The following seven systems were studied: H_2 + $DF-SbF_5$; $H_2 + D_2SO_4-SbF_5$; $H_2 + FSO_3D-SbF_5$; $D_2 + HF-SbF_5$; $D_2 + H_2SO_4-SbF_5$; $D_2 + FSO_3H-SbF_5$; and, $H_2 + D_2 + HF-SbF_5$. The exchange reaction indicates the intermediacy of isomeric $(H,D)_3^+$ ions in superacid solutions. (auth)

15291 ISOTOPIC EXCHANGE REACTIONS BETWEEN THALLIUM(III) IN COMPLEX COMPOUNDS AND ^{204}THALLIUM(I). Cecal, A.; Schneider, I. A. (Univ., Iasi). J. Phys. Chem.; 77: No. 15, 1904-1906(19 Jul 1973).

A study was made on the interdependence between the kinetic and thermodynamic parameters that describe the isotopic exchange between the complexes Tl(III) and ^{204}Tl(I), on one hand, and the structure and the nature of the chemical bond between the central metal and ligand in the complexes Tl(III)-N,N-diethyldithiocarbamate, Tl(III)-thenoyltrifluoroacetone, and $[HTlBr_4]$-diantipyrylmethane, on the other. From the experimental data, it is noted that the half time of the exchange reaction studied depends on the complexes used and decreases as follows: Tl(III)-N,N diethyldithiocarbamate > Tl(III)-thenoyltrifluoracetone > $[HTlBr_4]$ - diantipyrylmethane. This fact is due to the different structure and nature of the bonds which are involved between the central metallic ion and the ligand utilized. The pH influence on the exchange rates indicates the possibility of more or less hydrolysis of the given complexes and from the values of the activation entropies it can be concluded that the activated complexes which favor the electronic transfer between those two oxidation states have different probabilities of existence. (auth)

15292 TRITIUM EXCHANGE REACTIONS ON IRRADIATED SILICA GEL. Part 1. Activation of Molecular Tritium and Application to the Tritium Labelling of Aliphatic Hydrocarbons. Matthews, K. M.; Odell, A. L. (Univ. of Auckland, NZ). J. Chem. Soc., Dalton Trans.; No. 11, 1145–1148(1973).

The radiation-induced color in silica gel is bleached when tritium gas is admitted and this bleaching process activates the tritium in such a way that when a hydrocarbon is later admitted it becomes labelled. Best yields (up to 130 mCi g^{-1}) are obtained for aliphatic hydrocarbons having a methyl group attached to a tertiary carbon atom, often with a high degree of radiochemical purity. The number of tritium atoms incorporated appears to be comparable with the number of F centers in the irradiated silica gel. (auth)

15293 ENRICHMENT OF ^{7}Li BY COUNTERCURRENT ELECTROMIGRATION OF MOLTEN LITHIUM NITRATE. Okada, I.; Okuyama, K.; Miyamoto, T.; Tomita, I.; Saito, N. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 35: No. 8, 2957-2969(Aug 1973).

Lithium-7 was enriched from the natural abundance 92.58 to 99.94% (maximum) by countercurrent electromigration of molten lithium nitrate. In order to obtain high enrichment in a short time, fine packing material of quartz (≯150# mesh) has been used. Both cylindrical and pseudotruncated cone shaped separation tubes have been used and the latter are found to be more efficient for rapid enrichment. In both cases the distribution of the salt at a stationary state can be expressed approximately in terms of a truncated cone shaped distribution. The most favorable conditions for high enrichment are discussed in relation to the temperature, the grain size of the packing material and so forth. (auth)

15294 ISOTOPE EFFECTS IN THE ISOTOPE EXCHANGE EQUILIBRIA OF LITHIUM IN THE AMALGAM-SOLUTION SYSTEM. Okuyama, K.; Okada, I.; Saito, N. (Tokyo Univ.). J. Inorg. Nucl. Chem.; 35: No. 8, 2883-2895(Aug 1973).

The elementary separation factors for lithium isotopes in the isotope exchange equilibria between the amalgam and the organic solution were measured at several temperatures between –15 and 85°C. Dimethyl sulfoxide (DMSO), N,N′-dimethylacetamide (DMA), and N,N′-diethylformamide (DEF) were employed as the organic solvents for lithium salts. The separation factors with these systems were found to be larger than those reported previously with other chemical exchange systems. Lithium-6 was enriched in the amalgam phase in all the systems studied. The separation factors vary from 1.085 to 1.028, decreasing with an increase in the temperature. By plotting the logarithm of the separation factors vs the reciprocal of the square of the temperature, a nearly linear correlation was obtained. In the systems employing DMSO, the separation factors decrease in the following order: $\alpha_{CH_3COOLi} \approx \alpha_{LiI} \approx \alpha_{LiBr} > \alpha_{LiCl} > \alpha_{LiNO_3}$. The kind of the organic solvent has been found to affect the separation factor. The separation factors for the DMA or the DEF solution systems are larger than those for the DMSO-solution systems over the range of temperature investigated. The large separation factors obtained in these experiments indicate that the present isotope exchange process may be suitable for the enrichment of lithium isotopes. (auth)

15295 FRACTIONATION OF CARBON ISOTOPES. The Cyanex System: A Liquid–Liquid Chemical Exchange Process. Brown, L. L.; Drury, J. S. (Oak Ridge National Lab., TN). J. Inorg. Nucl. Chem.; 35: No. 8, 2897-2906(Aug 1973).

A new chemical method of fractionating carbon isotopes is reported. The closed-cycle process is based on the exchange reaction $(C_2H_5)_2C(OH)^{12}CN_{(xylene)} + K^{13}CN_{(aq.)} \rightleftharpoons (C_2H_5)_2C(OH)^{13}CN_{(xylene)} + K^{12}CN_{(aq.)}$. The single-stage isotopic separation factor is 1.035 at 20°C, with ^{13}C concentrating in the cyanohydrin species. The rate of exchange is rapid. Reflux is achieved by heating or cooling the process streams. The process solutions are chemically stable during prolonged periods of operation. Cost estimates indicate that the process (termed CYANEX, from CYANide EXchange) is more economical than any existing method for the production of high purity ^{13}C in large quantities. (auth)

15296 STUDIES IN $H_2O + D_2O$ MEDIA. 1. Kinetics of Tritium Exchange Between Trimethoxybenzene and Aqueous Perchloric Acid in $H_2O + D_2O$ Mixtures: Re-Evaluation of the Deuterium Fractionation Factor for the Aqueous Hydrogen Ion. Batts, B. D.; Kilford, J. (Macquarie Univ., North Ryde, Australia). J. Chem. Soc., Faraday Trans., I; 69: No. 6, 1033-1038(1973).

The kinetics of the hydrogen exchange reaction between 1,3,5-trimethoxy [2-^{3}H] benzene and aqueous 0.05 M perchloric acid in $H_2O + D_2O$ mixtures were studied. The results are used to calcu-

late the value for the isotopic fractionation of the hydrogen ion (1). Nine other systems already reported are similarly treated and a probable value for 1 is given as 0.72 ± 0.01. (auth)

15297 RADICAL ANIONS OF O-DICARBONYLBENZENES AND PHTHALIDES. Nelsen, S. F. (Univ. of Wisconsin, Madison). J. Org. Chem.; 38: No. 15, 2693-2697 (27 Jul 1973).

The ESR spectra of radical anions of o-acylbenzoates (I), alkyl o-acylbenzoates (II), phthalide (III), and 1-indanone (IV) are reported, and the spin distributions are discussed. Electrolytic reduction of alkyl o-acylbenzoates give II, and at higher potential mixtures of the 1,3 indandione obtained by Claisen condensation and I. 3-Alkoxy-phthalides give II, by an alkoxide-catalyzed cleavage. The hydrogens at C_3 of phthalide are rapidly replaced by deuterium in DMSO-d_6, as are those at C_2 of 1-indanone, but the C_3 hydrogens of 1-indanone do not exchange. (auth)

Feed Materials Processing

15298 VZAIMODEISTVIE FLOTATSIONNYKH REAGENTOV S MINERALAMI TSERIEVOI GRUPPY (NA PRIMERE MONAZITA). (Interaction of Flotation Reagents with Minerals in the Cerium Group (Based on the Example of Monazite)). Moscow; Izdatel'stvo Nauka (1972). 96p.

Monazite, a water-free phosphate of the Ce group of rare earths, has been a subject of flotation studies with a variety of flotation agents, oleic acid, naphthenic acids, and several synthetics. Based on published information on the influence of pH, the presence of inorganic salts, and the effect of organic reagent-regulators on the flotation of monazite, several analytical schemes are advanced for this process in connection with complex ores, complex basic syenites, monazite from sulfide quartz ores, and from special deposits which are geographically identified. (111 references.) (KSW)

Radiation Chemistry

Refer also to abstracts 15398, 15589, 15680, and 15686.

15299 (BNWL-1750(Pt.1), pp 63-64) RADIOLYTIC EFFECTS ON CHELATABILITY OF PuO_2. Smith, V. H.; Park, J. F.; Craig, D. K. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Ultrafiltration of Pu oxides, (^{238}Pu and ^{239}Pu) stored as aqueous suspensions, reveals increased solubility with time for the higher specific activity isotope ^{238}Pu. Complexing by DPTA is facilitated by the radiolytic degradation of the oxide and by length of contact time. (auth)

15300 (CALT-767-P-4-123) STUDIES IN CHEMICAL DYNAMICS AND RADIATION CHEMISTRY. Technical Progress Report, July 1, 1972–June 30, 1973. Kuppermann, A. (California Inst. of Tech., Pasadena). 30 Jun 1973. Contract AT(04-3)-767. 46p. Dep. NTIS $4.50.

Research progress is reported in the following areas: low energy electron scattering, photoelectron spectrometry, elementary reactions by photolysis at variable wavelengths, collisions in crossed molecular beams, and theory of chemical reactions and molecular collisions. (DHM)

15301 (COO-3286-5) CHEMICAL STUDY OF THE EFFECTS OF RADIATION ON NUCLEIC ACIDS AND RELATED COMPOUNDS. Annual Progress Report, August 1972–July 1973. Wang, S. Y. (Johns Hopkins Univ., Baltimore, Md. Dept. of Biochemistry). Jul 1973. Contract AT(11-1)-3286. 6p. Dep. NTIS $3.00.

Research progress is reported on the chemical study of the effects of radiation on nucleic acids and related compounds including isolation and identification of radiation products, synthesis of trans-1-carbamylimidazolidone-4,5 glycol, chromosomal aberrations by thymine hydroperoxide, and the effect of thymine hydroperoxide on nucleic acid components. (DHM)

15302 (COO-3416-10) RADIATION CHEMISTRY AND MASS SPECTROMETRY OF SILANES AND GERMANES. Progress Report, June 1, 1972–May 31, 1973. Lampe, F. W. (Pennsylvania State Univ., University Park). 1973. Contract AT(11-1)-3416. 71p. Dep. NTIS $5.75.

Research progress is reported in the following areas: ion–molecule reactions in monosilane–methane mixtures, ion–molecule reactions in disilane, and γ ray radiolysis of monosilane–nitric oxide mixtures. (DHM)

15303 (INIS-mf-338) IDENTIFICATION AND STUDY OF THE PARAMAGNETIC OPTICAL IONS OF IRRADIATED $Co(CN)_6^{3-}$ BY EPR AND OPTICAL ELECTROSCOPY. Caride, A. O. (Centre Experimental de Recherches et d'Etudes du Batiment et des Travaux Publics, Paris (France)). 15 Jun 1971. 153p. (In Portuguese). INIS.

Thesis.

Complex paramagnetic ions are studied by EPR. An intermediate state is detected when $Co(CN)_6^{3-}$ reduction is made. A computer code for energy levels (3D7-strong field) is presented. (auth)

15304 (NRCN-291) PULSE RADIOLYSIS OF METALLIC IONS IN AQUEOUS SOLUTIONS. Part I. Pulse Radiolysis of Hg^{2+} AND Hg_2^{2+}. Faraggi, M.; Amozig, A. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center, Negev). Feb 1971. 13p. Dep. NTIS (U. S. Sales Only).

Recent application of the pulse radiolysis technique has given interesting information about the transient intermediates produced in various systems. The present study contains results obtained by this technique in mercuric and mercurous ion acid solutions. (auth)

15305 (ORO-2825-32) STUDIES IN RADIATION AND CATALYTIC CHEMISTRY BY MASS SPECTROMETRY, FLASH PHOTOLYSIS, AND MAGNETIC TECHNIQUES. Final Report, January 1, 1971–December 31, 1972. Martin, T. W. (Vanderbilt Univ., Nashville, Tenn.). 10 Jan 1973. Contract AT(40-1)-2825. 6p. Dep. NTIS $3.00.

Progress is reported in three radiation and catalytic problems. The first problem was a study of the palladium-catalyzed oxidation of ammonia, methylamine, and hydrogen cyanide using a special higher pressure mass spectrometer, flow reactor, and sample collecting system. The catalyst temperature was varied from 40 to 450°C and the total pressure of reactants ranged from 10^{-3} to greater than 10^{-1} torr. The yields of intermediates and final products were measured as functions of P and T to reveal a comprehensive picture of the essential mechanistic steps for these reactions. The second problem was the first successful use of a combination pulse laser-pulse high field magnet technique to study both the generation and decay of the NO_3 free radical in aqueous solution and the photoisomerization of stilbene in benzene solution at room temperature. Two new magneto-chemical effects were positively demonstrated in this work and a more accurate value for the extinction coefficient at 635 nm for NO_3 was found to be $480 \pm 48\ M^{-1}\ cm^{-1}$. This new combination technique appears to be a useful way to detect the triplet state in fast reactions. The third problem was an electron spin resonance study of the various paramagnetic species generated upon photolysis of Ce(IV) salts in various acid solutions. This work has produced the first direct evidence for the existence of the hydronium free radical, H_3O, long sought for by many radiation chemists. Although this opinion and evidence have generated much controversy, it is felt that the claim will be vindicated eventually. (auth)

15306 (RRL-3238-436) QUARTERLY REPORT, JANUARY 1, 1973–MARCH 31, 1973. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 3 Apr 1973. Contract AT(11-1)-3238. 23p. Dep. NTIS $3.25.

Short summaries are given on research reports published for the period January 1, 1973 to March 31, 1973. Progress on other investigations is briefly reported including ESR study of the reaction of OH radicals with anilines and aminophenols; reaction of OH radicals with phosphate esters; pulse radiolysis study of CN and HCN in aqueous solutions; high efficiency columns for use in aqueous liquid chromatography; oxidation of aromatic free radicals by cupric sulfate; effects of positive ion scavengers on the secondary electron transfer reactions as a probe for the existence of a high mobility hole; radiation chemistry in micellar systems; electron attachment rates for simple halides; and ion neutralization rates in pulse irradiated gases. (DHM)

15307 KINETICS OF FREE RADICAL ACCUMULATION IN POLYMERS UNDER SIMULTANEOUS AND PERIODIC ACTION OF IONIZING RADIATION AND LIGHT. Zhdanov, G. S.; Milinchuk, V. K. (Scientific-Research Physical-Chemical Inst., Moscow). Vysokomol. Soedin., Ser. A; 14: No. 11, 1405-2412(Nov 1972). (In Russian).

A kinetic calculation was carried out on the accumulation of free radicals formed in optically transparent polymers under simultaneous and periodic action of penetrating radiation and light. The cases of radical disappearance under the action of light according to the first- and second-order equations were considered. The kinetics of accumulation of allyl and peroxide radicals in polypropylene under simultaneous and periodic action of γ radiation and light at 300°K was studied by the ESR method. The experimental curves obtained are in satisfactory agreement with the calculated data. (auth)

15308 OBSERVATIONS ON SOLVATED ELECTRONS IN ALIPHATIC HYDROCARBONS AT ROOM TEMPERATURE BY PULSE

RADIOLYSIS. Baxendale, J. H.; Bell, C.; Wardman, P. (Univ. of Manchester, Eng.). J. Chem. Soc., Faraday Trans., I; 69: No. 4, 776-786(1973).

The spectra of solvated electrons (e_s^-) in n-hexane, cyclohexane, methylcyclohexane, and isopentane at room temperature were obtained. Electron–cation recombination reactions are second order and have rate constants 1-20 × 10^{14} M^{-1} s^{-1} at 20°C. The rate constants for the reaction of e^- with pyrene and carbon tetrachloride in n-hexane are 1.0 × 10^{12} M^{-1} s^{-1}, and the latter reaction has an activation energy of 5 ± 1 kcal mol^{-1}. The relationship of these observations to mobilities of electrons in hydrocarbons measured by conductivity is discussed. (auth)

15309 PULSE RADIOLYSIS STUDIES ON AQUEOUS SOLUTIONS OF INORGANIC SULPHUR COMPOUNDS. Kabachia, V. K. Saskatoon Saskatchewan; Univ. of Saskatchewan (1972). 175p. University Microfilms Order No. 73-8122.

Thesis (Ph. D.).

The effects of 17-MeV electron pulses on aqueous solutions of sulfur anions were studied. Reactions of the anions with hydrated electrons were measured by determining the decay rates of the e^-_{aq} absorption at 578 nm in deaerated water and in deaerated solutions of the anions. The tetrathionate, trithionate, and dithionite ions were found to react rapidly with e^-_{aq} ($k > 10^9$ M^{-1} sec^{-1}); the thiosulfate and hydrogen sulfide ions were found to react at moderate rates ($k > 10^7$ M^{-1} sec^{-1}); the dithionate ion was found to be relatively inert towards e^-_{aq} ($k > 10^7$ M^{-1} sec^{-1}). Irradiated tetrathionate solutions yielded a transient ($S_2O_5^-$) absorbing in the near uv with λ_{max} at 370 nm. The radical ion was formed by a rapid reaction between the solute and e^-_{aq}. The transient produced in dithionate solutions ($S_2O_4^-$) resulted from the OH radical electron transfer reaction and showed absorption in the visible with λ_{max} at 590 nm. Three absorbing species were formed in irradiated thiosulfate solutions. These showed absorption maxima at 380, 280 and 290 nm and were identified with the $S_3O_3^-$, S_2^- and SO_3^- radical ions, respectively. The hydrogen sulfide system was only briefly investigated. The spectra obtained could be divided into three parts based on their decay characteristics and effects of various radical scavengers on them. The three absorption peaks were tentatively attributed to S_2^- (λ_{max} 280 nm), polysulfides (λ_{max} 350–380 nm) and HS_2^- (λ_{max} 410–430 nm). The decay kinetics of the absorbing radicals were investigated, and mechanisms for their formation and consumption were discussed. (Diss. Abstr. Int., B)

15310 UNSTABLE INTERMEDIATES. Pt. 124. Alkyl Radical-halide Ion Adducts. Mishra, S. P.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Perkin Trans., II; No. 4, 391-394(1973).

A recent suggestion that methyl bromide in methyl cyanide when exposed to γ rays at 77°K gives methyl radicals that are loosely associated with their parent bromide ions was examined, the previous ESR results were confirmed, and the bromine hyperfine tensor components were obtained. These show that transfer of spin to bromine is small, and it may be that spin density is acquired mainly by spin polarization. Similar results were obtained from methyl iodide and ethyl bromide. t-Butyl bromide gave only $Me_3C^\cdot$ radicals. The same compounds in methyl alcohol gave only the corresponding alkyl radicals with no halide interaction. This difference is explained in terms of the far greater anion solvating power of the alcohol. Methylene bromide in both solvents gave Br_2^- $HCBr_2$ but no species corresponding to the bromide ion adducts. The pure compounds on irradiation at 77°K gave dihalide anions and other products, but no halide ion adducts. In contrast, N-chloro- and N-bromo-amides gave σ^* radical anions without loss of halide ion, both in methyl cyanide and in methyl alcohol. These differences are explained in terms of the different structures of the organic radicals formed by loss of halide ions. (auth)

15311 ENDOR STUDY OF γ-IRRADIATED SINGLE CRYSTALS OF SODIUM HYDROGEN OXALATE MONOHYDRATE, $NaHC_2O_4 \cdot H_2O$. Edlund, O.; Lund, A.; Graeslund, A. (Forskningsraadens Lab., Studsvik, Sweden). J. Magn. Resonance; 10: No. 1, 7-14 (Apr 1973).

CO_2^- ions which become trapped after room temperature irradiation display hyperfine interactions with three hydrogen bonded protons. This demonstrates that the radical retains approximately the orientation of the parent ion. The coupling tensors can be reasonably accounted for by a theoretical estimate of dipolar interactions. (auth)

15312 KINETICS OF CHARGE SCAVENGING IN γ IRRADIATED LIQUIDS WITH LARGE FREE ION YIELDS. Dodelet, J. P.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem.; 50: No. 17: 2729-2738(1 Sep 1972).

The extent to which the calculated scavenging yields are affected by the form of the ion–electron spacial distribution decreases as the free ion yield increases. The increasing free ion yield may be due to larger electron ranges or to a larger dielectric constant. The free ion yields in neopentane and water are respectively 1.0 (due to large electron ranges) and 2.7 (due to large dielectric constant). The scavenging yields in neopentane calculated with three different forms of spacial distribution, using the forced diffusion (FD) approximation, are significantly affected by the form of the spacial distribution. The scavenging yields in water calculated with four different forms of spacial distribution, using the FD approximation, are all within the experimental error of the measured yields. Use of the prescribed diffusion (PD) approximation permits satisfactory yields to be calculated for neopentane, but leads to the unsatisfactory result that all of the secondary electrons in the liquid have the same range (delta function distribution YD). The scavenging yield curves obtained using the PD approximation for water did not have a steep enough slope even when the distribution YD was used; YD leads to a steeper slope than any other form of distribution. The PD approximation gives an overestimate of the breadth of the geminate neutralization time distribution. The calculated time required for half of the geminate neutralization reaction to occur is similar whether the FD or PD approximation is used, but the spread of the neutralization times is an order of magnitude greater from the latter than from the former. Calculations were also done for electron scavenging in methylcyclopentane and in methanol. Methylcyclopentane behaves like cyclohexane and methanol behaves much like water with regard to the kinetics of ion–electron reactions in the spurs. (auth)

15313 ELECTRON SPIN RESONANCE SPECTRA FOR ADAMANTYL RADICALS IN THE SOLID STATE; ^{13}C HYPERFINE COUPLING CONSTANTS. Mishra, S. P.; Symons, M. C. R. (Univ. of Leicester, Eng.). Tetrahedron Lett.; No. 25, 2267-2270 (Jun 1973).

It is stated that well resolved liquid-phase ESR spectra for bridgehead adamantyl radicals have established their pyramidal character. The proton hyperfine parameters agree with those calculated by the INDO M.O. method, and differ from those expected for planar radicals. In this connection it is of interest to measure the ^{13}C coupling constants for such radicals. One-bromoadamantane was exposed to ^{60}Co γ-rays at 77°K to obtain the 1-adamantyl radical. This species should have ^{13}C hyperfine tensor components sufficiently large to be clear of the wings of the central line, and this was found to be the case at very high gain. A table is presented showing the ^{13}C hyperfine tensor components assigned to 1-adamantyl radicals in various media (CD_3OD, CD_3CN, CS_2 and 1-bromoadamantane) at 77°K. It is concluded that the results confirm previous work and show that relatively slight relaxation towards planarity has occurred, in contrast to comparable results for normal alkyl radicals, which are almost certainly planar or nearly so. (UK)

15314 ELECTRON SPIN RESONANCE STUDIES OF THE EFFECT OF γ-RADIATION AND OF HYDROGEN ATOMS UPON VARIOUS OLEFINIC CARBOXYLIC ACIDS AND THEIR AMIDES. Neilson, G. W.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Perkin Trans., II; No. 4, 397-399(1973).

Olefinic carboxylic acids and amides (e.g., acrylic acid, acrylamide, crotonic acid, methacrylamide, α-methacrylic acid, ββ-dimethacrylic acid) were studied at 77°K and room temperature after exposure to H atoms and γ rays. At 77°K certain radicals (e.g., $Me_2C^\cdot \cdot CO_2H$, from α-methacrylic acid and $Me_2\dot{C} \cdot CH_2 \cdot CO_2H$ from ββ-dimethacrylic acid) were observed, some of which were converted into polymer radicals on annealing to room temperature [e.g., $RCH_2 \cdot \dot{C}Me(CO_2H)$ from α-methacrylic acid]. Several differences between H atom and γ bombardment were noticed, especially the tendency of H atoms to add to olefinic bonds in cases where γ rays gave allylic radicals. Results are discussed in terms of reaction mechanisms. (auth)

15315 UNSTABLE INTERMEDIATES. Pt. 125. H(R)CN Radicals in γ-Irradiated Cyanoacetic Acid and Acidic Solutions of Methyl Cyanide. Mishra, S. P.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Perkin Trans., II; No. 4, 394-396(1973).

Exposure of cyanoacetic acid to ^{60}Co γ rays at 77°K gave radicals whose ESR spectra were characteristic of $H_2\dot{C}CN$ and $H(CH_2CO_2H)\dot{C}N$ radicals. The latter had $a(^1H) = 85$ G, $a_{||}(^{14}N) = 32$ G, $a_{\perp}(^{14}N) = 0 \pm 2$ G, and $a(^1H)(CH_2) = 3$G. Similarly, aqueous sulfuric or acetic acid glasses containing methyl cyanide gave, among several radicals, H(Me)CN, with similar magnetic parameters. These results were supported by studies of CD_3CN in D_2SO_4–D_2O. Possible mechanisms are discussed. (auth)

15316 TRICHLOROMETHYL AND OTHER RADICALS IN IR-RADIATED SINGLE CRYSTALS OF TRICHLOROACETAMIDE. Kispert, Lowell D. (Department of Chemistry University of Alabama, Tuscaloosa, Alabama 35486); Rogers, Max T. J. Chem. Phys. 58: No. 5, 2065-2070 (1 Mar 1973).

The trichloromethyl radical has been identified in irradiated single crystals of trichloroacetamide. When the magnetic field lies along the a axis of the monoclinic crystal it is also nearly normal to the plane of the three chlorine atoms and the spectrum may be interpreted as the superposition of spectra from the radicals $^{35}Cl_3C.$, $^{35}Cl_2{}^{37}ClC.$, and $^{35}Cl^{37}Cl_2C.$ with the expected abundance ratios 27:27:9. To a good approximation ^{35}Cl and ^{13}C hyperfine splittings in this orientation may be taken as the principal values of the ^{35}Cl and ^{13}C hyperfine splitting tensors, $A_{xx}(^{35}Cl) = 18.1G, A_{xx}(^{13}C) = 136G$. Although the complexity of the spectra precludes a complete determination of the hyperfine tensors, these data are sufficient to show that the radical is nonplanar, and to provide considerable information concerning the electronic structure. (auth)

15317 ELECTRON–ELECTRON DOUBLE RESONANCE OF IRRADIATED DIMETHYLMALONIC ACID, α-AMINOISOBUTYRIC ACID, AND L-ALANINE SINGLE CRYSTALS: THE ROLE OF METHYL SUBSTITUENTS. Kispert, Lowell D.; Chang, Kichoon; Bogan, Carolyn M. (Department of Chemistry, University of Alabama, Tuscaloosa, Alabama 35486). J. Chem. Phys. 58: No. 5, 2164-2176 (1 Mar 1973).

Electron–electron double resonance (ELDOR) spectra of the $(CH_3)_2CCOOH$ radical in irradiated single crystals of dimethylmalonic acid and α-aminoisobutyric acid, the $(CH_3)_2\dot{C}COOD$ radical in irradiated N,N-dideutero-α-aminoisobutyric acid single crystals, and the $CH_3\dot{C}HCOOD$ radical in irradiated single crystals of deuterium substituted l-alanine (CH_3CHND_2COOD) were measured over a temperature range from 170 to 370°K. Two competing relaxation mechanisms, a electron–nuclear dipole relaxation (END) and cross relaxation mechanism, resulted in an observed reduction in the allowed ESR lines above 283°K with ELDOR lines observed at a_H, $2a_H$, $3a_H$, and $4a_H$. Below 283°K an enhancement of the ESR line occurred at a_H, a reduction at $2a_H$ and negligible ELDOR intensity at higher multiples of a_H. The qualitative aspects of the temperature dependence of the ELDOR spectrum of $(CH_3)_2CCOOH$ can be explained in terms of the correlation times of the intramolecular dynamic processes Approximate calculations based on these mechanisms give reasonable agreement with experiment. (auth)

15318 RADIOLYSIS OF INORGANIC MOLECULAR IONS IN CRYSTALLINE SOLIDS. Raman Spectroscopic Measurements of the Decomposition of ^{18}O- and ^{15}N-Enriched Polycrystalline Potassium Nitrate and Potassium Nitrite by Cobalt-60 γ-Rays. Boyd, G. E.; Brooker, M. H. (Oak Ridge National Lab., TN). J. Amer. Chem. Soc.; 95: No. 15, 4816-4821(25 Jul 1973).

Laser-excited Raman spectroscopy was employed in the quantitative measurements of the changes produced in the relative abundances of the isotopic nitrate and nitrite ions in oxygen-18- and nitrogen-15-enriched polycrystalline KNO_3 and KNO_2 when these solids were irradiated at room temperature under vacuum and in air with ^{60}Co γ-rays. Strong support for an oxygen-atom mechanism for the radioinduced decomposition of nitrate ion was given by the observed random substitution of ^{18}O in this ion and in the nitrite ion formed in the KMO_3 by prolonged irradiation under vacuum. The radiolytic oxygen gas possessed the same enrichment as the nitrate from which it was formed and ^{18}O also was randomly substituted, suggesting that a radioinduced dissociation of O_2 must occur. Irradiations of solid solutions of ^{15}N-enriched KNO_2 in KNO_3 yielded $K^{15}NO_3$ and $K^{14}NO_2$, consistent with the view that oxygen-atom transfer occurred and with the fact that a random substitution of ^{18}O occurred in the enriched KNO_2 (and in its nitrate impurity) when it was irradiated under vacuum. Irradiations in air caused extensive ^{16}O exchange with ^{18}O-enriched KNO_3 and KNO_2, but no exchange of ^{14}N from air with the respective ^{15}N-enriched salts was detected. (auth)

15319 RADIATION INITIATED PROCESS FOR THE GRAFT COPOLYMERIZATION OF BINARY MONOMER MIXTURES AND CELLULOSE. Arthur, J. C. Jr.; Harris, J. A. (to Secretary of Agriculture). U. S. Patent 3,733,257. 15 May 1973. Filed Date 19 Nov 1971. 8p.

Industrial textiles and rigid-construction cellulose–copolymer products are produced by processes of this disclosure. The fibrous cellulosic material is dried in the absence of oxygen to a moisture content of about 2%; γ-irradiated with a ^{60}Co source, then reacted with one of several binary monomer mixtures, which are in certain preferred solvent mixtures, and washed. (Official Gazette)

15320 PROCESS FOR THE SOLVENT CASTING OF CELLULOSE FILMS USING RADIATION, AND PRODUCTS THEREOF. Dotson, B. R.; Morrison, E. D.; Williams, R. F. Jr. (to Eastman Kodak Co.). U. S. Patent 3,738,924. 12 Jun 1973. Filed Date 6 Jul 1971. 6p.

Significantly increased processing rates can be obtained when cellulose ester dopes used in solvent casting processes for manufacturing cellulose ester film products (for photographic film base, for example) are modified with one or more compatible monomeric materials capable of undergoing free radical polymerization, and the resulting cast (modified) dopes are irradiated with high-energy radiation to polymerize the compatible monomer portion of the dope before the cast layer is stripped from the casting web. The resulting film products have properties equal to or better than conventional cellulose ester films in spite of the degradation of the cellulose ester material by the high-energy radiation. (Official Gazette)

15321 PULSE RADIOLYSIS OF DITHIOTHREITOL. Redpath, J. L. (Mount Vernon Hospital, Northwood, Eng.). Radiat. Res.: 54: No. 3, 364-374(Jun 1973).

Dithiothreitol was used in model experiments to investigate its free radical reactivity in relation to its properties as a radioprotector. Absolute rate constants for the reaction of this sulfydryl compound with hydroxyl radicals and secondary inorganic radical anions have been determined using the technique of pulse radiolysis. The repair of several organic free radicals by their reaction with dithiothreitol was demonstrated. Transient absorption spectra observed after reaction of these radicals with this –SH compound were measured. (auth)

15322 URACILYL RADICAL PRODUCTION IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS OF THE 5-HALOURACILS. Bhatia, K.; Schuler, R. H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 77: No. 15, 1888-1896(19 Jul 1973).

The γ radiolysis of dilute aqueous solutions of 5-bromo-, 5-chloro-, and 5-fluorouracil was investigated by liquid chromatographic and by pulse radiolysis conductometric methods with attention being focussed on determining the importance of the production of 5-uracilyl radical as an intermediate. In the chromatographic study both the consumption of the starting material and formation of uracil were examined in the presence of a suitable H atom donor. It is concluded that at pH 7 the reaction of hydrated electrons with 5-bromo- and 5-chlorouracil yields 5-uracilyl radical essentially quantitatively. From the conductometric study it is apparent that the loss of chloride from the anion radical initially produced by reaction of e^-_{aq} with 5-chlorouracil is sufficiently slow that in acidic solutions protonation is important and as a result 5-uracilyl radical is produced only in reduced yield. It is estimated that in this case protonation competes with dissociation on equal terms at pH 5.2. For 5-bromouracil protonation of the intermediate anion radical is unimportant even at pH 3 indicating that in this case the anion intermediate has a lifetime $<10^{-7}$ sec. The hydrated electron reacts rapidly with 5-fluorouracil but does not give any appreciable yield of 5-uracilyl radical. In neutral solution the anion radical formed by reaction of e^-_{aq} with uracil is shown to transfer electrons to each of the halouracils and result in their reaction even when they are present as only a minor component in the system. With 5-bromouracil $>10^{-5}$M this transfer reaction is 100% efficient. Auxiliary results are presented on other aspects of the radiolysis of the halouracils. (auth)

15323 YIELDS AND DECAY OF THE HYDRATED ELECTRON AT TIMES GREATER THAN 200 PICOSECONDS. Jonah, C. D.; Hart, E. J.; Matheson, M. S. (Argonne National Lab., IL). J. Phys. Chem.; 77: No. 15, 1838-1843(19 Jul 1973).

The yields of the hydrated electron were measured at times greater than 200 psec after irradiation with 19-MeV electrons as 4.1 ± 0.1 e^-_{aq}/100 eV of energy deposited. The yield and the decay of e^-_{aq} were also measured in the presence of 1 M CH_3OH, 1 M NaOH, and 1 M CH_2OH plus 1 M NaOH. The results confirm the concept of high local concentrations in the initial stages after energy deposition (the spur theory), but the time dependence of $[e^-_{aq}]$ differs from that predicted by published spur diffusion model calculations. (auth)

15324 PULSE RADIOLYSIS STUDIES OF NITROFURANS. Radiation Chemistry of Nifuroxime. Greenstock, C. L.; Dunlop, I. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). J. Phys. Chem.; 77: No. 15, 1834-1838(19 Jul 1973).

Under the effects of pulsed electron irradiation hydrated electrons, hydrogen atoms, and hydroxyl radicals react with nifuroxime with rate constants of 3.8×10^{10}, 3.0×10^9, and 1.0×10^{10} M^{-1} sec^{-1}, respectively. There is little change in hydrated electron or hydroxyl radical reactivity from pH 4 to 10. The optical absorption spectra of the adduct species formed by e^-_{aq}, H, or OH addition to nifuroxime peak at 395, 400, and ≤ 375 nm and their molar extinction coefficients are 3900, 500, and 400 M^{-1} cm^{-1}, respectively. The pK_a's for protonation of the three primary

species adducts are below 3.0. The nitrofurans have a high electron affinity and oxidize a variety of biochemical donor radicals and radical anions. However, oxygen reacts rapidly with both electron and hydroxyl radical adducts of nifuroxime with rate constants of 1.6×10^9 and 1.4×10^9 M^{-1} sec^{-1}, respectively. (auth)

15325 DECAY OF HYDRATED ELECTRONS IN RADIOLYTIC SPURS AT PICOSECOND TIMES. Rzad, S. J.; Schuler, R. H. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 77: No. 15, 1926-1928(19 Jul 1973).

A recent report of the radiolytic yield of hydrated electrons as observed at subnanosecond times by both the stroboscopic pulse radiolysis technique and by direct measurements with single pulses indicates that $G(e^-_{aq})$ is $\sim 4.0 \pm 0.2$ on the 30 to 1000-psec time scale. This yield is somewhat lower than the value of 4.8 required in the calculations of Schwarz to explain the net observed yield of water decomposition on the basis of the spur diffusion model. Furthermore very little decay was observed over the period 30 to 350 psec after irradiation in contrast to the expected ~15% drop. Results of this study indicate that, to a large extent, these observations can be accommodated by the spur diffusion model provided hydration requires a period $\sim 10^{-12}$ sec. (auth)

15326 RADIOCHEMICAL INVESTIGATION ON HYDROCARBONS AND ORGANIC SULFUR COMPOUNDS. 2. General Aspects, Experiments, and Oxidation of Cyclohexane. Boberg, F.; Striefler, B. (Technische Univ., Hanover). Erdoel Kohle, Erdgas, Petrochem.; 25: No. 7, 389-393(1972). (In German).

A review is given of reactions of hydrocarbons with and without oxygen under the influence of radiation. Under fixed conditions the radioinduced liquid phase oxidation is studied. The oxidation of cyclohexane is discussed in particular. (GE)

15327 MECHANISM OF RADIOLYTIC REDUCTION OF Cr(VI) IN AQUEOUS SOLUTIONS. Fiti, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Chim.; 18: No. 3, 511-517(Mar 1973).

The mechanism of Cr(VI) reduction to Cr(III) hydrated electrons, and hydrogen atoms is discussed. In the presence of specific OH radical scavengers, such as alcohols, the Cr(VI) reduction occurs with $G[-Cr(VI)] = G[Cr(III)]$ depending on Cr(VI) concentration, acidity, additives, and dose-rate. In neutral, deaerated solutions and in the presence of t-butanol the reduction occurs directly by e^-_{aq} and H ($G_{red} = G_H + G_{e^-_{aq}} = 3.2$) because $G[-Cr(VI)] \simeq \frac{1}{3} G_{red} = 1.05 \pm 0.05$. In the presence of methanol and in acid solutions, G[-Cr(VI)] exceeds largely the value required by the above equation; the reduction is controlled by chain reaction mechanism, propagated by the H, HO_2, and CH_2OH radicals. Yields for both electron beam and γ irradiations are tabulated. (auth)

15328 HETEROGENEOUS STRUCTURE AND THERMOMECHANICAL PROPERTIES OF ORIENTED POLYETHYLENE WITH GRAFT POLYACRYLONITRILE. Kurilenko, A. I.; Krul, L. P.; Gerasimov, V. I.; Bakeev, N. F. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk SSSR; 209: No. 1, 144-146(1 Mar 1973). (In Russian).

Polyethylene films were stretched and then permitted to swell in a mixture of benzene–acrylonitrile at 20°C while being exposed to γ-radiation from a ^{60}Co source. This procedure insured good distribution of the grafted polyacrylonitrile. The structures and the internal stresses of control polyethylene and grafted polyethylene were studied as functions of the temperature over the range 60 to 160°C with the aid of large and small angle roentgenograms. The grafted structure precluded the relaxation of the oriented macromolecules in fused polyethylene. (KSW)

15329 TUNNELLING ROTATION RATE OF A WEAKLY HINDERED METHYL GROUP. Clough, S.; Poldy, F. (Nottingham Univ., Eng.). J. Phys., C (London); 6: No. 11, 1953-1964(11 Jun 1973).

Electron spin resonance spectra and electron nuclear double resonance measurements are presented for free radicals with the structure $CH_3\dot{C}OHCOO^-$ formed by γ irradiation of crystals of lithium lactate. The splitting of the ground state due to the tunnelling rotation of the methyl group is found from the temperature dependence of the populations of the split levels which are reflected in the relative heights of constituent lines of the hyperfine structure. The amplitude of the zero-point torsional oscillation is measured from the relative magnitude of hyperfine coupling tensors and the height of the hindering barrier is deduced from the temperature dependence of the ESR spectrum. All the measurements are consistent with a tunnelling splitting of 22 ± 5 GHz. (auth)

15330 GAMMA RADIOLYSIS OF WATER USING A SPECIALLY DESIGNED GAMMA-IRRADIATION LOOP. Koike, M.; Tachikawa, E.; Hashimoto, H.; Ohkubo, T. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 111-117 (Feb 1973).

The γ radiolysis of water was studied using a water-loop specially designed for this purpose. The water was circulated without contact with air during the irradiation. The apparent $G(H_2)$ value was found to be roughly 10^{-3}. However a corresponding amount of O_2 was not found, due to its consumption by corroding reactions of the constituent materials under radiation field. In the presence of O_2 and H_2O_2, the H_2-yield curves vs. the irradiation dose revealed a very distinctive characteristic: following a rapid increase with initial irradiation a plateau range has appeared. The H_2-yield at this plateau range depended on the initial concentration of additives. Continued irradiation, however, caused a gradual further rise in the H_2-yield above the plateau value at a rate corresponding to that found in the pure water system. These yield curves are discussed on the basis of the free radical model for the radiolysis of water. (auth)

15331 RADIOINDUCED POST-POLYMERIZATION OF SOLID N PHENYLMALEIMIDE USING A DIATHERMIC CALORIMETER. Migunova, I. I.; Kaplan, A. M.; Mikhailov, A. I.; Ivanov, V. S.; Barkalov, I. M. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. A; 15: No. 5, 977-981(May 1973). (In Russian).

The kinetic characteristics of the solid-phase γ-induced post-polymerization of N-phenylmaleimide were studied using a diathermic calorimeter. The temperature dependence of the post-polymerization rate shows two maxima, which can be explained by the freezing and reviving phenomena of growing polymeric chains. The heat of polymerization of N-phenylmaleimide as well as the activation energy values of this process were determined. Both the ESR spectra and the optical bleaching results point to the radical mechanism of the solid-phase polymerization. (auth)

15332 ELECTRON SPIN RESONANCE STUDY OF FREE RADICALS PRODUCED IN AN IRON(0)–DIENE SYSTEM. Anderson, O. P.; Symons, M. C. R. (Univ. of Leicester, Eng.). Inorg. Chem.; 12: No. 8, 1932-1934(Aug 1973).

Dicarbonylcyclohexadienetriphenylphosphineiron(0), $(C_6H_8)Fe(CO)_2PPh_3$ was irradiated in the pure solid state, and in glassy n-butyl chloride and 2-methyltetrahydrofuran. The first of these solvents generates the n-butyl radical (n-Bu) on irradiation at 77°K, $n\text{-}BuCl + e^- \rightarrow n\text{-}Bu + Cl^-$, and the ESR spectrum is dominated by features from the n-Bu radical. The latter produces large numbers of physically trapped electrons (e^-_t) which normally give rise to an intense blue color and ESR singlet, but which are readily added to any substrate present. (DHM)

15333 EFFECT OF TRANSITION METAL OXIDE ADDITIONS ON RADIATION-CATALYTIC ACTIVITY OF ALUMINUM AND MAGNESIUM OXIDES. Vladimirova, V. I.; Zhabrova, G. M.; Krylov, O. V. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 449-451(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 510-513(1972).

The effect of added impurities (transition metal ions and adsorbed water) on the radiation catalytic activity of aluminum and magnesium oxides during the radiation-induced conversion of methanol was studied. It is shown that the introduction of cobalt and molybdenum ions into the surface layer of aluminum oxide and highly calcined magnesium oxide does not disturb the energy transfer process. For magnesium oxide calcined at low temperatures a decrease in the overall yield of radiolytic products was observed. It is suggested that the reduction in yields arises from competition between methanol molecules and hydroxyl ions on the surface of magnesium oxide for the capture of excess carriers. (auth)

15334 γ-RADIOLYSIS OF GASEOUS HYDROGEN SULPHIDE IN THE PRESENCE OF HYDROGEN CHLORIDE, CARBON DISULPHIDE, AND NITROUS OXIDE. Huyton, D. W.; Woodward, T. W. (Salford Univ., Eng.). J. Chem. Soc., Faraday Trans., I; 69: No. 6, 1049-1055(1973).

Addition of HCl to H_2S increases the radiation yield of H_2 $G(H_2)$ 7.0 → 10.0 by an electron scavenging process involving HCl and H_2S. CS_2 lowers the H_2 yield in pure H_2S probably by reaction with hot H atoms and also scavenges the electrons in H_2S + HCl mixtures, lowering $G(H_2)$ in the process to <7.0. Electron scavenging by addition of N_2O to H_2S to produce N_2 is shown to be a very complex system with surface reactions probably playing a part. (auth)

15335 PHOTOSTIMULATED RECOMBINATION LUMINESCENCE OF γ-IRRADIATED METHYLCYCLOHEXANE AND CYCLOHEXANE AT 77°K. Kulakov, V. V.; Nikol'skii, V. G. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 452-455(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 514-518(1972).

Results are reported of a study of the kinetics of decay of the radiophotoluminescence (RPL) of crystalline cyclohexane, and of crystalline and amorphous samples of methylcyclohexane, at 77°C. It was shown that as the dosage is increased above 1 Mrad there occurs in all the tested samples a diminution of the mean duration of luminescence. The period of RPL τ is connected with the concentration of stabilized radicals [R] by the relation $1/\tau = 1/\tau_0 + k_2[R]$, which indicates competition between processes of recapture of photodetached electrons by radicals and their recombination with positive ions. (auth)

15336 RADIOLYSIS OF VINYL BROMIDE. Analysis of the Radiolytical Products. Gamache, A.; Herman, J. A. (Laval Univ., Quebec). J. Chim. Phys.; 70: No. 3, 437-442(Mar 1973). (In French).

The γ radiolysis of gaseous vinyl bromide gives the following products: C_2H_2, HBr, C_2H_4, and H_2. An increase of the radiochemical yields of C_2H_2 and HBr with pressure is observed. Ethylene is produced in radical reaction (60%) involving C_2H_3 and HBr and the remaining 40% are formed in neutralization processes or hot hydrogen atom addition reactions. (FR)

15337 EFFECT OF VISIBLE LIGHT ON γ-IRRADIATED INCLUSION COMPOUNDS OF METHYL ALKYL KETONES WITH UREA. Karasev, A. L. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 456-460 (1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 519-524(1972).

Under the effect of γ-irradiation on inclusion compounds of methyl alkyl ketones (methyl ethyl ketone, methyl propyl ketone, methyl butyl ketone) with urea the following charged species are formed: e^-_{capt}, primary cation radicals $\overset{CH_3}{\underset{R}{\diagdown}}C{=}\dot{O}^+$, secondary cation radicals $\overset{\dot{C}H_2}{\underset{R}{\diagdown}}C^+-OH$, and anion radicals $\overset{CH_3}{\underset{R}{\diagdown}}\dot{C}-O^-$. Upon irradiation of γ-irradiated inclusion compounds with light of wavelength $\lambda \geq 700$ nm e^-_{capt}, and primary and secondary cation radicals disappear and an additional amount of anion radicals is formed. Since the walls of the cavities in the inclusion compounds are electron donors, the electrons are stabilized mainly in canals, and after being freed from traps under the effect of light they move along the canals, recombining with cation radicals and adding to neutral ketone molecules with formation of anion radicals. The concentration of anion radicals decreases under the effect of light having wavelength $\lambda \geq 380$ nm and methyl radicals form; the reverse process occurs upon turning off the light. This reversible transformation is described by the following scheme: $\overset{CH_3}{\underset{R}{\diagdown}}C\cdot-O^- \overset{h\nu}{\rightleftarrows} \dot{C}H_3 + RCO^-$. It was established that the course of processes, occurring under γ-irradiation of methyl alkyl ketones by means of light, changes significantly upon including them in the lattice of urea. (auth)

15338 RADIOLYSIS OF NF_3 AND N_2F_4 UNDER THE ACTION OF FAST ELECTRONS. Cherednikov, V. N. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 461-463(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 525-528(1972).

The radiolysis of NF_2 and N_2F_4 exposed to fast electrons of energy ~30 MeV was investigated. Values of the radiation yield for the decomposition of NF_3 and N_2F_4 were determined, and the dependence of the rates of radiolysis on pressure and dose strength were obtained. It is shown that tetrafluorohydrazine is more unstable to radiation than is nitrogen trifluoride: $G(-N_2F_4) \approx 20$. (auth)

15339 INFLUENCE OF pH ON THE STATIONARY CONCENTRATIONS OF MOLECULAR RADIOLYSIS PRODUCTS OF WATER. Raichevskii, G. (Inst. of Physical Chemistry, Sofia). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 464-469(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 529-535(1972).

The stationary state of the radiolysis of water under "equilibrium" conditions, in an inert medium, in the absence of acceptors or impurities, and without a free volume above the liquid phase, was investigated by the method of potentiostatic coulometry. The values of the stationary concentrations of the molecular products H_2 and H_2O_2, which proved to be of the order of 10^{-7} M, were determined. These stationary concentrations of H_2 and H_2O_2 are substantially below those determined heretofore. The dependence of the stationary phase on the pH in the range 2 to 14 was investigated. With increasing pH, the stationary concentrations decrease greatly, as is demonstrated by qualitative kinetic analysis. On the basis of the accepted reaction scheme, an estimation of the concentrations of H and OH radicals in the stationary state was made: 10^{-9} M. (auth)

15340 ROLE OF IONS IN RADIATION POLYMERIZATION MECHANISM OF VINYL CHLORIDE IN GAS PHASE. I. Investigation of the Mobility of Vinyl Chloride Ions. Volkov, N. G.; Gorbachenko, G. M.; Deev, Yu. S.; Lyapidevskii, V. K. (Moscow Engineering-Physics Inst.). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 483-484(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 552-553(1972).

The mobility of the charge carriers in vinyl chloride were measured in order to clarify the role of ions during the polymerization process. The gas was irradiated with α particles from ^{239}Pu which was placed into a collimator and mounted into the chamber so that the tracks of the particles emerged close to and parallel to the plane of the high-voltage electrode. Results show that propagation of the polymer chains through ions does not take place and their role can only be to initiate the neutral active radical centers. The formation of radicals can take place either during the recombination of the ions or by their interaction with unexcited or excited molecules. (DHM)

15341 ROLE OF IONS IN RADIATION POLYMERIZATION MECHANISM OF VINYL CHLORIDE IN GAS PHASE. II. Investigation of Electron Attachment in Vinyl Chloride. Volkov, N. G.; Gorbachenko, G. M.; Lapidus, O. V.; Lyapidevskii, V. K. (Moscow Engineering-Physics Inst.). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 485-486(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 553-555(1972).

An investigation of electron attachment in vinyl chloride was carried out in a pulse ionization chamber with parallel-plate electrodes, and the electrons (and ions) were created in the gas by α particles. The rate of drift of the electron in the vinyl chloride–argon mixture in the fields investigated is largely dependent on the E/P_{vp} (where P_{vp} is the partial pressure of vinyl chloride in the mixture and does not depend on the Ar concentration), indicating that the interaction cross sections between the electrons and vinyl chloride molecules are large. The dependence of the capture probability on pressure for low electron energy supports an attachment process in which three particles participate. When E/P (which expresses the average energy of the electrons) > 3 to 3.5 V/cm mm of Hg, a new competing process switches in. At this time, the capture probability starts to increase with an increase in the energy of the electrons. The independence of h (probability of capture) on pressure in this process (when $E/P > 5$ at any rate) is most probably connected with the dissociative mechanism of the electron attachment to the vinyl chloride molecules. (DHM)

15342 RADIOLYSIS OF SOLUTIONS OF URANYL NITRATE IN METHANOL IN A NUCLEAR REACTOR. Bulanov, L. A.; Borovkov, V. V.; Borisov, E. A. (Physical Chemistry Inst., Moscow). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 487-488(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 555-556(1972).

The effect of uranyl nitrate concentration on the yields of ethylene glycol and formaldehyde from solutions exposed to mixed radiation in a nuclear reactor and to fission fragments. It was found that on introducing uranyl nitrate into the methanol the yield of ethylene glycol due to mixed reactor radiations fall systematically, and at 1.5×10^{-2} M reaches 0.2. However, the yield of formaldehyde, under the same conditions rises to 6.1. When exposed to fission fragments, the ethylene glycol yield is not significantly different from that obtained with mixed reactor radiations at least for solutions 5×10^{-3} M or more in uranyl ions. The formaldehyde yield varies only slightly with uranyl nitrate concentration. (DHM)

15343 RADIATION CHEMICAL REACTIONS IN BUTADIENE–ACRYLONITRILE COPOLYMERS IN PRESENCE AND ABSENCE OF INHIBITORS. Il'icheva, Z. F.; Zigmunt, M. M.; Degteva, T. G.; Slovokhotova, N. A. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 489-490(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 556-558(1972).

By means of ir and electron spectra measurements the structural changes occurring on exposure of butadiene–nitrile rubber to ionizing radiations in the presence and absence of inhibitors (various derivatives of secondary aromatic amines) were studied. The following conclusions were reached: (1) On irradiating rubber without additives crosslinking occurs through the nitrile groups, as shown by the conversion of the $-C\equiv N$ group to $C{=}N-$ during irradiation and the similar behavior of a number of $-C\equiv N$ groups in the copolymers and the rate of its radiation-induced crosslinking. (2) The observation by spectrometry of ionic particles in rubber irradiated at low temperature, and the reduction of ion formation on irradiating rubber containing an additive, with

the simultaneous appearance of an ion of the additive, and a sharp reduction in the crosslinking yield, indicate an ionic crosslinking mechanism. (DHM)

15344 RADIOLYSIS OF AQUEOUS SOLUTIONS OF $[Cr\ en_3]Cl_3 \cdot 3.5\ H_2O$. Nekokladnova, L. N.; Silivanchik, I. P.; Pansevich, V. V. (Belorussian State Univ., Minsk). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 491-493(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 558-559(1972).

The radiolysis of aerated and carefully vacuum-degassed aqueous neutral and acidic solutions of $[Cr\ en_3]Cl_3 \cdot 3.5\ H_2O$ in a wide range of complex salt concentrations (5×10^{-4} to 1 M) and of radiation doses (2×10^{16} to 2×10^{18} eV/ml) was studied. Radiolytic conversions of $[Cr\ en_3]Cl_3 \cdot 3.5\ H_2O$ in neutral degassed solution are accompanied by the formation of simple salts of divalent chromium. The radiative yield $G(Cr^{2+})$, calculated graphically from the straight-line sections of the curves, is 1.85, 3.89, and 5.38 molecules/100 eV for concentrations of 5×10^{-3}, 1×10^{-2}, and 5×10^{-2} M, respectively. The concentration of Cr^{2+} rapidly reaches a steady value with increasing dose. In experiments with acceptors, it was established that divalent chromium is formed by reaction of the starting salt with e^-_{aq}, with H atoms and with OH radicals. In the presence of Na_2CO_3, KBr, and CH_3OH, $G(Cr^{2+})$ decreases from 3.89 to 1.46, 1.33, and 1.27 molecules/100 eV, respectively. The presence of reducing particles ($NaNO_3$) in the acceptor solution also leads to a lowering of $G(Cr^{2+})$. When $[NaNO_3] = 1.6$ M, $G(Cr^{2+})$ reaches a value of 1.84 molecules/100 eV. In the presence of HCOONa (H and OH acceptor radicals) the data obtained (bear witness to the fact that the reactivity of e^-_{aq} towards the central atom is greater than the reactivity of atomic hydrogen. (DHM)

15345 SYNTHESIS OF GRAFTED COPOLYMERS OF CAPRON WITH IONIZED GROUPS IN SIDE CHAINS. Musaev, U. N.; Khaidarov, K. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 4, 36-37(1973). (In Russian).

The presence of tertiary N in a grafted copolymer offers the possibility of side chains with ionized groups having specialized properties. The synthesis of such a grafted copolymer was accomplished using as an aminoalkyl monomer, N-N'-dimethylaminoethyl methacrylate, which when treated with HCl in benzene solution, produced a chlorohydrate. Alkylation of the monomer was accomplished with an ethereal solution of ethyl iodide, and subsequent grafting to capron (nylon) fiber utilized ^{60}Co-emitted gamma radiation at different dose levels. The resulting grafted copolymer was much more hygroscopic and more light-stable than the original capron fiber. (KSW)

15346 LOW-TEMPERATURE RADIOLYSIS OF AROMATIC AND HALOGENATED HYDROCARBONS. Funk, W. Diss. Nr. 4655. Zurich; Eidgenoessische Technische Hochschule (1971). 153p. (In German).

Thesis.

A cryostat was constructed which permitted irradiation with 2 MeV electrons. A ^{60}Co source supplied γ radiation. The irradiation was performed on organic glasses at the temperature of liquid nitrogen. By means of spectroscopy, the behavior of transients originating at 77°K was followed during thawing. Generally, the substance under study was dissolved in 3-methylpentane which forms a glass at 77°K. Several new transients were observed. It was found that characteristics of the matrix, especially its viscosity and polarity, significantly affected the absorption spectra of transients. A semi-empirical method was developed which allowed prediction of the capability of organic liquids to form glasses at 77°K. (HBG)

15347 KINETICS OF RADIOINDUCED IONIC GRAFT COPOLYMERIZATION. Kabanov, V. Ya.; Sidorova, L. P. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. A; 15: No. 6, 1373-1377(Jun 1973). (In Russian).

The kinetics of the γ-radioinduced ionic grafting of vinyl-n-butyl ether on high- and low-pressure polyethylene were studied at room temperature with thorough drying of monomer and the whole system. The ionic mechanism of grafting is confirmed by the monomolecular chain termination, the negative activation energy value, and the highly effective inhibition of grafting by water traces. (auth)

15348 EFFECT OF γ IRRADIATION ON THE STABILITY OF POLY(VINYL CHLORIDE) PLASTICIZERS. Krylova, S. V.; Kulikova, A. E.; Obchinnikov, Yu. V.; Berlyant, S. M. Plast. Massy; No. 1, 16-18(1973). (In Russian).

A study was made of the effect of γ radiation on the chemical stability of esters of phthalic, sebacic, and adipic acids, and the effect of the nature of the acid and alcohol radicals of plasticizers on their behavior during γ radiation. The γ irradiation of plasticizers led to a sharp increase in their acidity; therefore, variation of this index was taken as one of the criteria for evaluating the degree of decomposition of the plasticizers. The degree of decomposition depends significantly on the length of the alcohol radical. With an increase in length of this radical the acidity of the plasticizer and ΔN increase (N is the number of carboxyl groups in the plasticizer). The decomposition of the esters is described. The results of the effect of the nature of the alkyl radical of esters of phthalic acid on their resistance to γ radiation and the effect of the acid radical on the resistance of poly(vinyl chloride) plasticizers to γ radiation are tabulated. After subjecting dioctyl phthalate and dioctyl adipate to γ radiation with different initial acidities, it was found that the greater the initial acidity of these compounds, the less the relative increase in acidity after irradiation. The increase in acidity for dioctyl phthalate after irradiation was always less than for dioctyl adipate. Thus, dioctyl phthalate has self-defensive properties with respect to γ radiation. The high stability of "acid" plasticizers can be explained by the fact that the high content of free carboxylic acid in the initial esters prevents their decomposition under the effect of γ radiation. The stabilization of the esters by carboxylic acid probably arises from the absorption or dissipation of some portion of the γ radiation energy. (JPRS)

15349 EFFECT OF ADDITIVES ON THE RADIATION DECOMPOSITION OF POLYISOBUTYLENE. Tikhomirova, N. S.; Bol'shakov, N. I.; Serenkov, V. I. Plast. Massy; No. 1, 18-19 (1973). (In Russian).

A study was made on the effect of certain organic additives on the decomposition of polyisobutylene under the effect of cobalt γ radiation in the presence of oxygen. Aromatic compounds with conjugated rings, phenols, and aromatic thio compounds in the form of especially pure reagents and chemically pure compounds were used as additives. The protective effect of the additives azobenzene, α-dinitrophenol, and p-aminophenol was found to be a function of the absorbed dose. With an irradiation dose of one mrad, the effectiveness of protecting the polyisobutylene is maximal, and with a further increase in the dose to 3 mrad the protection becomes weaker. The effect of the various investigated additives on radiolysis of polyisobutylene was analyzed, leading to the following groupings: phenols (ionol, p-aminophenol, α-dinitrophenol) and azobenzene, which protect the polymer chains from breaking in the presence of irradiation. Their protective functions are connected with deactivation of the active radiolysis products. Captax and altax were found to promote the radioinduced decomposition of polyisobutylene in the absence of oxygen. The compounds, p-aminophenol and diphenylthiourea, actively affect the radioinduced oxidation of polyisobutylene, suppressing it significantly at comparatively low concentrations (up to 1% by weight). (JPRS)

15350 GAMMA-RAY INDUCED ADDITION REACTION OF CYCLIC ETHERS TO TETRACHLOROETHYLENE. Yumoto, T. (Government Industrial Research Inst., Nagoya, Japan); Matsuda, T. Nippon Kagaku Kaishi; 1973: No. 3, 556-562(Mar 1973). (In Japanese).

Cyclic ethers were found to add to tetrachloroethylene with γ-ray irradiation and to produce saturated and unsaturated 1:1-adducts that contain $CHCl_2-CCl_2-$ and $CCl_2=CCl-$ groups, respectively. The effects of dose rate, total dose, temperature, and structure of reactant on the reaction mode were studied. G values of adducts change in the following order: tetrahydrofuran > oxetane > 1,3-dioxolane > tetrahydropyran > p-dioxane. p-Dioxane gives mainly unsaturated 1:1-adduct; on the other hand, 1,3-dioxolane gives mainly saturated 1:1-adduct. These adducts were produced with the reaction rates independent of the dose rate. Apparent activation energies are estimated in the cases of some cyclic ethers. The addition reaction of this type was found to proceed with organic peroxide catalysts. (auth)

15351 APPEARANCE OF SULPHATOFERRIC COMPLEXES IN THE OXIDATION OF FERROUS SULPHATE SOLUTIONS. A Study by Pulse Radiolysis. Jayson, G. G. (Liverpool Polytechnic, Eng.); Parsons, B. J.; Swallow, A. J. J. Chem. Soc., Faraday Trans., I; 69: No. 6, 1079-1089(1973).

The rate of the reaction between perhydroxyl radicals and ferrous ions, like that between hydroxyl radicals and ferrous ions, is little affected when the ferrous ions are associated with sulphate. However, sulphate ions displace HO_2^- from the ferric hydroperoxide complex by an outer-sphere ion-pair formation mechanism (I_d): $SO_4^{2-} + Fe^{3+}(H_2O)_6$, $HO_2^- \rightleftharpoons Fe^{3+}(H_2O)_6$, $HO_2^-SO_4^{2-}$; $Fe^{3+}(H_2O)_6$, $HO_2^-SO_4^{2-} \rightarrow Fe^{3+}(H_2O)_5SO_4^{2-} + HO_2^- + H_2O$. The equilibrium constant for the first of these reactions is $90 \pm 20\ M^{-1}$, and the rate constant for the second is approximately $10^4\ s^{-1}$. Sulphate reacts with the ferric-hydroperoxide-ferrous bridge compound similarly, with an equilibrium constant of $100 \pm 20\ M^{-1}$ and a rate constant of the same order of magnitude as for the ferric hydroperoxide

complex. Additional reactions take place when the concentration of sulphate ions is high enough. New determinations have been made of the rate constants and activation parameters for the reaction of hydrated ferric ions with sulphate. A detailed mechanism is given for reactions occurring during irradiation of the Fricke dosimeter in the absence of sodium chloride. (auth)

15352 CHEMICAL RADIOSENSITIZATION OF PHOSPHATE ESTER CLEAVAGE. Raleigh, J. A.; Greenstock, C. L.; Kremers, W. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Int. J. Radiat. Biol.; 23: No. 5, 457-467(May 1973).

The action of ionizing radiation on aqueous solutions of phosphate esters, including nucleotides and model phosphate ester derivatives of phospholipid membranes, causes the release of inorganic phosphate. Studies with selective radical scavengers implicated hydroxyl radicals as the principal reactive species in this process. In the presence of compounds of high electron affinity, an enhanced radiolytic yield of inorganic phosphate was observed in anoxic and nitrous oxide-saturated solutions. In the radiolysis of 10^{-2}M phosphate ester solutions, optimum radiosensitization occurred at sensitizer concentrations between 1 and 5×10^{-4}M. The degree of radiosensitization increased with the electron affinity of the added radiosensitizers (N-ethyl maleimide (NEM), nitrobenzene (NB), p-nitroacetophenone (PNAP), and nitrofurazone (NF_1)). Comparison of radiosensitization for different phosphate esters showed that the degree of sensitization was strongly determined by the structure of the phosphate ester. (auth)

15353 EFFECTS OF γ-RADIOLYSIS ON SOLUTIONS OF PAPAIN. Lynn, K. R.; Louis, D. (National Research Council of Canada, Ottawa). Int. J. Radiat. Biol.; 23: No. 5, 477-485(May 1973).

Highly-purified papain was γ irradiated in atmospheres of oxygen, nitrogen, and nitrous oxide. A simultaneous decline in papain activity and in the sulphydryl content was observed. By use of dithiothreitol the loss of enzymatic ability was separated into recoverable and nonrecoverable parts. Amino acid analyses demonstrated that some nonrecoverable damage consisted of oxidation of cysteine residues to cysteic acid. The remainder was by formation of products which, on hydrolysis in two different acids, yielded analyses indistinguishable from those for unirradiated enzyme. It is suggested that these products may include sulphenic acid and the results of disulphide interchanges incorporating the essential Cys 25; similar but readily reducible products must account for the recoverable damage observed on radiolysis. (auth)

15354 RADIATION EFFECTS FROM ^{60}Co-GAMMA RAYS ON ION EXCHANGE RESINS. Takahashi, S.; Sakai, K. (Tokai Univ., Tokyo). Tokai Daigaku Kiyo Kogakubu; 1972: No. 2, 65-68(Mar 1973). (In Japanese).

An experimental study on the irradiation effects of ^{60}Co γ radiation on the properties of ion exchange resins is described. Use is made of cation exchange resins, i.e., Amberlite IR-118, IR-120L, IR-121, and Dowex 50W-X10, which are conditioned in H-form. After γ irradiation at 10^6 to 10^8 R, the adsorption and capacity loss of each sample are investigated on ferric ion, by the use of ^{59}Fe(III) radioactive tracers. The adsorption loss ranges approximately from 15 to 30% in the case of irradiation with 1×10^6 R; the exchange capacity loss increases slightly in the case of irradiation not below 1×10^6 R. (auth)

15355 LUMINESCENCE FROM 2,3-DIMETHYLBUTANE CONTAINING TOLUENE IN THE SOLID PHASE AT 77°K DURING GAMMA IRRADIATION. Miyazaki, T.; Saitake, Y.; Kuri, Z. I.; Sakai, S. (Nagoya Univ., Japan). Bull. Chem. Soc. Jap.; 46: No. 1, 70-74(Jan 1973).

The luminescence from 2,3-dimethylbutane (2,3DMB) containing toluene in the solid phase was measured at 77°K during γ-irradiation. The emission consists of fluorescence and phosphorescence from toluene. Since the emission becomes zero upon the removal of a γ-ray source, it cannot be due to a post-irradiation effect. It is concluded from the dependency of the intensity on the concentration of toluene that the luminescence is due to an intermolecular energy transfer from 2,3DMB to toluene during γ irradiation. ESR studies of γ-irradiated 2,3DMB containing toluene were also undertaken at 77°K in order to obtain some information on the intermolecular energy transfer. The toluene anion is formed in the γ-irradiated 2,3DMB containing toluene. The dimer cation of toluene is formed in the γ-irradiated 2,3DMB containing toluene and an electron scavenger. The luminescence from toluene in the 2,3DMB matrix decreases upon the pre-irradiation of the sample at 77°K. When the pre-irradiated sample is illuminated by the light from a tungsten lamp to photobleach the toluene anion, the luminescence during γ irradiation is recovered. Since the intensity of the luminescence does not correspond at all to the amount of toluene anions, the luminescence from toluene in the 2,3DMB matrix during γ irradiation must not be due to a neutralization reaction between a toluene anion and a migrating hole. It is suggested that the migration of energy from the irradiated 2,3DMB to toluene may occur via an excitation transfer reaction. (auth)

15356 ABSORPTION SPECTRA OF IRRADIATED FILMS OF POLY(VINYL CHLORIDE) COATED WITH PERYLENE. Yashiro, D.; Ueda, H. (Government Chemical Industrial Research Inst., Tokyo). Tokyo Kogyo Shikensho Hokoku; 68: No. 1, 14-18(Jan 1973). (In Japanese).

The visible and uv spectra of γ-irradiated films of poly(vinyl chloride) doped or coated with perylene were recorded. These films were irradiated either under a vacuum, in N_2O, or in NH_3. In the case of a film the surface of which has been coated with perylene, an absorption maximum at 560 mμ was observed. When the same film was irradiated in N_2O, this absorption maximum was also observed. However, when it was irradiated in NH_3, this absorption maximum was not observed. In the case of a film in which perylene has been dissolved, this 560 mμ absorption maximum was not observed, either. As the absorption maximum at 560 mμ coincided with that of perylene cation already reported, it was concluded that the perylene cation forms only on the surface of a film of poly(vinyl chloride). As the absorption of the energy of the γ-ray takes place on the surface of the film at the same rate, per electron density, as that inside the film, it was concluded that the stabilization of the perylene cation, the precursors of which can migrate throughout the film, occurs only on the surface of the polymer film. (auth)

15357 PULSE- AND GAMMA-RADIOLYSIS OF SELENIUM-CONTAINING COMPOUNDS: SELENOCYSTINE. Tamba, M.; Badiello, R. (Consiglio Nazionale delle Ricerche, Bologna). Int. J. Radiat. Biol.; 23: No. 5, 435-445(May 1973).

Aqueous solutions of selenocystine were irradiated with ^{60}Co gamma rays and with pulses of 2 MeV electrons. Radical scavengers, such as nitrous oxide and aliphatic alcohols, were used to isolate effects of the various primary radicals. Chromatographic, polarographic, spectrophotometric, and radiochemical techniques were used for the determination of the degree of destruction and for the identification of the radiolysis products. Pulse radiolysis showed the presence of a transient species formed by e^-_{aq}; it absorbed strongly with a maximum at 440 nm and decayed rapidly by a first-order reaction to give a second species (maximum at 460 nm) that disappeared by a second-order reaction. Similar absorption at 460 nm and similar second-order decay were found for the transient species formed by the OH reaction. (auth)

15358 ORTHOGONAL-FUNCTION EXPANSIONS APPLIED TO SOLUTION OF THE DIFFUSION-KINETIC EQUATIONS OF RADIATION CHEMISTRY. Haskin, F. E.; Faw, R. E. (Department of Nuclear Engineering, Kansas State University, Manhattan, Kansas 66506). J. Chem. Phys. 58: No. 8, 3255-3266 (15 Apr 1973).

A new method is presented for solving the diffusion–kinetic equations describing diffusion and reaction of chemically active species along the tracks of ionizing radiations in liquids. Orthogonal–function expansions reduce the partial differential equations to interlinked ordinary differential equations which may be solved readily using standard numerical techniques. The convergence of the orthogonal–function expansion technique and its applicability for complex chemical reaction mechanisms are discussed and a comparison is made between experimental and theoretical results for radiolysis of cyclohexane. (auth)

15359 ESR STUDY OF RADICALS FORMED IN γ-IRRADIATED SINGLE CRYSTALS OF $K_2NBOF_5.H_2O$. Shock, John R.; Rogers, Max T. (Department of Chemistry, Michigan State University, East Lansing, Michigan 48823). J. Chem. Phys. 58: No. 8, 3356-3364 (15 Apr 1973).

A single-crystal ESR study has been made of $K_2NbOF_5.H_2O$ γ irradiated at 77°K. Two ^{93}Nb-centered radicals were observed at 77°K; one of these is shown to be $[NbOF_5]^{3-}$ with a d^1 configuration and a d_{xy} ground state and the g, A(^{93}Nb), and A (^{19}F) tensors for this radical have been evaluated. The A(^{19}F)fluorine superhyperfine interaction tensor for the equatorial fluorine ligands indicates strong in–plane π bonding between the niobium $4d_{xy}$ orbital and the $2p_y$ orbitals of fluorine. The g and A(^{93}Nb) parameters have also been used to calculate molecular orbital coefficients for this complex. On warming, the $[NbOF_5]^{3-}$ radical decays at –80°C leaving a second radical, the ESR spectra of which suggest that it is a hole species formed by the removal of an electron from $[NbOF_5]^{2-}$. (auth)

15360 KINETICS OF THE LOW TEMPERATURE DEAMINATION OF RADICALS IN L-ALANINE AND α-AMINOISOBUTYRIC ACID. Shields, Howard; Hamrick, Phillip J. Jr.; Smith, Clyde; Haven, Ysbrand (Departments of Physics and Chemistry, Wake Forest University, Winston-Salem, North Carolina 27109). J. Chem. Phys. 58: No. 8, 3420-3423 (15 Apr 1973).

The rate constants for the deamination of radicals in x-irradiated l-alanine and α-aminoisobutyric acid have been determined at temperatures around 150°K. The reactions are first-order with activation energies of 7.5 and 14.1 kcal/mole, respectively, and pre-exponential factors 1×10^{9} sec^{-1} and 3×10^{16} sec^{-1}, respectively. (auth)

15361 ELECTRON-SPIN RESONANCE OF N_4^- DEFECTS IN IRRADIATED RbN_3. Guha, Champa; Bogan, L. D.; Gilliam, O. R. (Department of Physics and Institute of Materials Science, University of Connecticut, Storrs, Connecticut 06268). Phys. Rev. B 7: No. 9, 4047-4051 (1 May 1973).

An N_4 molecular ion is observed by ESR at 92 K in single-crystal rubidium azide (RbN_3) following uv or γ irradiation at 77 K and a 35-min anneal at 227 K. The ESR spectra are characteristic of an unpaired electron interacting equally with four equivalent nitrogen nuclei. The spin-Hamiltonian parameters are similar to those of the planar N_4^- defect in KN_3; however, the growth and annealing behaviors of this defect differ in these two crystals. For both materials, trapped nitrogen atoms found following irradiation anneal at about 150 K. In both, N_4^- ions are formed from thermal annealing at approximately 200 K; however, the N_2^- intermediate reported in KN_3 is not identified in RbN_3. Slow thermal decay of N_4^- defects in RbN_3 occurs at temperatures as low as 227 K. From measurements of the rate of decay at several temperatures an annealing activation energy of 0.47±0.04 eV is determined, which is approximately one-half that found for N_4^- ions in KN_3. (auth)

15362 EFFECT OF CHARGE SCAVENGERS ON THE SCAVENGING OF CHARGES OF OPPOSITE SIGN. THE CONSEQUENCES ON THE STEADY STATE AND PULSE RADIOLYSIS OF LIQUID HYDROCARBONS. Infelta, Pierre P. (Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556); Rzad, Stefan J. J. Chem. Phys. 58: No. 9, 3775-3784 (1 May 1973).

The scavenging of positive ions and electrons in hydrocarbons is re-examined in terms of a model where the mobilities of positive and negative charges both decrease upon scavenging. The phenomenological model is applied to steady state and pulse radiolysis and explicit expressions describing such phenomena are obtained. The quantitative results obtained for cyclohexane by treating the available experimental data in this manner are discussed. Specifically the mobility of the hole is estimated to be $\sim2\times10^{-2}$ cm^2 $V^{-1}.sec^{-1}$ and λ, the constant characterizing the ion recombination processes in pure cyclohexane is interpreted to be $\sim7\times10^{11}$ sec^{-1}, which indicates that half of the original ions recombine in ~1 psec. Estimates of $\sim7\times10^{11}M^{-1}.sec^{-1}$ and $\sim10^{13}M^{-1}$ sec^{-1} are obtained for the rate constants for scavenging of positive ions and electrons respectively. It is shown that the presence of a hole scavenger should affect drastically the time dependent behavior of the secondary negative ions and optimum conditions for experiments of this sort are discussed. (auth)

Radiochemistry and Nuclear Chemistry

15363 ANNIHILATION OF POSITRONS IN HYDROCARBONS AND HALOGENATED HYDROCARBONS ADSORBED ON SILICA GEL. Tumosa, Charles S.; Wang, Cherng-Maw; Ache, Hans J. (Department of Chemistry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). J. Chem. Phys. 58: No. 5, 1833-1837 (1 Mar 1973).

Positron lifetime spectra of a series of hydrocarbons and halogenated aromatic compounds adsorbed on silica gel have been studied as a function of adsorbate concentration. The fact that the anomalous long lifetime component found in pure silica gel is not affected by adsorbate concentration up to 1.5-1.7 millimole per gram SiO_2 indicates that thermalized positronium cannot react chemically with these compounds. The decrease of the intensity of the long lifetime component with the adsorbate concentration can be interpreted in terms of positron capture by these compounds or by chemical reactions of highly energetic Ps-atoms with the adsorbate molecules. (auth)

Hot-Atom Chemistry

15364 (NP-19805) HELIUM-JET TRANSPORTATION OF RECOIL ATOMS INTO A LIQUID PHASE. Puumalainen, P.; Aysto, J.; Valli, K. (Jyvaskyla Univ. (Finland). Dept. of Physics). Mar 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

A rapid, inexpensive method was developed for transportation of recoiling short-lived radioactive nuclides from a target chamber over distances of several meters into a liquid phase. This allows rapid radiochemical separation of different elements. The carrier-loaded helium-jet transport technique is employed without a pumping system. The method would appear to be applicable to most chemical elements. The transport efficiency is higher than 50% and the transport time can be made much shorter than 1 s. Radiochemical separation times of a few s were achieved. (auth)

15365 REACTION OF HOT HYDROGEN ATOMS WITH ETHYLENE. Penzhorn, R. D. (Kernforschungszentrum, Karlsruhe, Ger.); Lissi, E.; Rivas, I.; Soto, H. Z. Phys. Chem. (Frankfurt); 83: No. 1-4, 200-204(1973).

The reaction of hot hydrogen atoms with ethylene was studied employing the photolysis of H_2S as the source of H atoms. The effect of moderators such as CO_2 and He on the quantum yield of products was investigated. He and CO_2 increased the rate of C_2H_6 formation in contrast to recently published results. Comparison of He and CO_2 moderation effects indicated that these moderate hot H atoms rather than hot ethyl radicals. (GE)

15366 ANNEALING PROBABILITIES OF SZILARD-CHALMERS RECOILED SPECIES AT CATIONIC AND ANIONIC SITES IN Co(3) DOUBLE COMPLEXES. Lazzarini, A. L. F.; Lazzarini, E. (Politecnico, Milan). J. Inorg. Nucl. Chem.; 35: No. 8, 2653-2657(Aug 1973).

The isochronal annealing of ^{60}Co recoiled species in the cationic and anionic sites of neutron irradiated hydrated trans-[Co $en_2(NO_2)_2$] [Co EDTA]H_2O was measured and the results are compared with those obtained previously for cis-[Co $en_2(NO_2)_2$][Co EDTA]3 H_2O. The retentions in cationic sites are linearly correlated with those in anionic sites, but the slope of the line is different for the hydrated and anhydrous salts and for cis and trans salts. It is also shown that the slopes of the lines depend on the atmosphere in which the annealing takes place. The results are briefly discussed in terms of the solid state isotopic exchange model for annealing reactions of recoiled species. (auth)

15367 AFTER-EFFECTS OF ISOMERIC TRANSITION STUDIED IN FROZEN SOLUTIONS OF TIN COMPOUNDS. Murin, A. N.; Bondarevskii, S. I.; Dzhurzha, V. V.; Tarasov, V. A. (Leningrad State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 435-437(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 494-497(1972).

The after-effects of a reversed isomeric transition in frozen solutions of tin compounds were studied by means of the Moessbauer method and utilization of a scintillation resonance detector. After-effects of the nuclear conversion related to the nature of the local surrounding of the Moessbauer atoms were found in all cases. Conclusions are drawn regarding the factors which determine the possibility of stabilizing the hot atoms undergoing reversed isomeric conversion in various states. (auth)

15368 ENERGETIC REACTIONS OF ^{80}Br ACTIVATED BY (I.T.) PROCESS IN $C_3H_8-C_2H_6$ AND $C_3H_8-CH_3Br$ SYSTEMS. Numakura, K.; Tachikawa, E. (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 46: No. 2, 346-351(Feb 1973).

In order to examine the relative importance of the thermal ionic process in the reactions of ^{80}Br from the (I.T.) process with C_3H_8, C_2H_6 or CH_3Br were used as diluents. Some assumptions were made in estimating the yield-variation of products from the diluents: (1) the rate of the reduction of the yields of the products from C_3H_8 caused by the addition of the diluent is the same for all of the products and (2) the ionic yield is zero over the whole range of concentrations of C_3H_8. With these assumptions, the analysis of the results shows that the contribution of the thermal ionic process in these binary systems has only minor importance; the products are, essentially, formed via energetic processes. It is also found that the ratio of n-$C_3H_7{}^{80}Br$/i-$C_3H_7{}^{80}Br$ per bond basis seems to decrease from 1.1 ± 0.1 on the addition of the diluent. This indicates that the formation of i-$C_3H_7{}^{80}Br$ is a lower energy process, relative to that of n-$C_3H_7{}^{80}Br$ in the present reaction system. (auth)

15369 ADDITIONAL FORMATION OF $CH_2{}^{80}BrBr$ VIA A KINETIC ENERGY-INDEPENDENT PROCESS IN HIGHLY MODERATED $^{80m}Br-CH_4$ SYSTEMS. Numakura, K.; Saeki, M.; Tachikawa, E. (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 46: No. 1, 1-4(Jan 1973).

The moderator effect of Kr on the reaction of (I.T.)-activated ^{80}Br with CH_4 was examined, keeping the ratio of Br_2/CH_4 at 0.02 or 0.05. The yield of $CH_2{}^{80}BrBr$ shows a slight decrease at the beginning of moderation and then tends to increase with further moderation. These facts suggest an additional formation of $CH_2{}^{80}BrBr$ via a thermal ionic process in highly-moderated systems. When the concentration of Br_2 is varied in the system containing 10 cm Hg of CH_4 and from 40 to 36 cm Hg of Kr, the yield of $CH_2{}^{80}BrBr$ first increases and then decreases, showing a broad maximum. This dependence not only partly explains the inconsistence of the present results with those previously reported, but also suggests the competition of two types of reaction in its formation. One must be the reaction of a radioactive radical with Br_2, leading to the formation of $CH_2{}^{80}BrBr$: $\cdot CH_2{}^{80}Br + Br_2 \rightarrow$

$CH_2^{80}BrBr$. The other type of reaction is a scavenging reaction of Br_2 for the reacting ^{80}Br atom. (auth)

Properties of Radioactive Materials

Refer also to abstracts 15222, 15262, 15826, and 15827.

15370 (AAEC/E-255) STRUCTURES OF FLUORIDES. II. The Structure of Uranyl Fluoride. Taylor, J. C.; Wilson, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1973. 16p. Dep. NTIS (U. S. Sales Only) $3.00.

A neutron powder diffraction study of UO_2F_2 was carried out. Previous workers have proposed that line broadening in the diffraction pattern of UO_2F_2 is due to puckering of the hexagonal fluorine atom rings and consequent stacking disorders. In this study it was found that most of the line broadening is due to the effects of particle size and shape. The puckering of the layers, if present, must be determined from a neutron analysis of the deviation of the z-coordinate of the fluorine atom from the value 0.333, using reflexions for which $h-k = 3n$. There are only two resolved lines of this type in the pattern, making it difficult to decide whether the previously proposed complex disorder structures are better than a simple model where the layers are unpuckered. It was found that single crystal studies will be necessary to distinguish between the alternative models. (auth)

15371 (CEA-CONF-2307) AMERICIUM CHALCOGENIDES (SULPHIDES AND SELENIDES). Damien, D.; Berger, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 9p. (CONF-711078-1). Dep. NTIS (U. S. Sales Only) $3.00.

Americium chalcogenides, in particular selenides and sulfides, were prepared and studied by x-ray diffraction and thermogravimetric analysis. Dissociation behavior of the selenides and sulfides is discussed. Lattice parameters are compared with those of rare-earth, Np, and Pu selenides or sulfides. (JGB)

15372 (CEA-R-4406) ELECTROCHEMICAL BEHAVIOR OF THE STATES OF OXIDATION OF Pu IN A SODIUM HYDROXIDE MEDIUM. Bourges, J. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1973. 79p. (In French). Dep. NTIS (U. S. Sales Only) $6.00.

Thesis. Submitted to Paris Univ. (France).

Electrochemical behaviour of Pu(V)/Pu(VI) and Pu(VI)/Pu(VII) systems was investigated in sodium hydroxide solutions. Contrary to earlier predictions, Pu(V) is found to be stable in alkaline solutions. Three proofs of Pu(V) existence were established, a method of Pu(V) dosage by ferricyanure is also recommended. The Pu(V)/Pu(VI) system is almost reversible in 4 M NaOH, his formal potential being about: 0,25 V/ENH in NaOH 2 M to 4 M. Formal potential of Pu(VI)/Pu(VII) system has been found close to: 0,94 V/EHN in NaOH 1 M. (auth)

15373 (INIS-mf-363) RAMAN SPECTRA OF URANIUM CHLORIDES COMPLEXES. Zilberstein, A. (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). Feb 1972. 46p. (In Hebrew). INIS.

Thesis.

The following complexes were synthetized: $UCl_5 \cdot (Cl_2CCClCOCl)$, UCl_5PCl_5, UCl_5SOCl_2, $CsUCl_6$, $[(CH_3)_4^+]UCl_6^{2-}$; $CsUCl_6$, $(CH_3)_4NUCl_6$, $(n\text{-}C_3H_7)_4NUCl_6$, and UCl_5; UCl_6. Because these complexes undergo oxidation and hydrolysis easily, it was necessary to work under dry nitrogen. The syntheses are described in detail and their Raman spectra and some other chemical and physical properties are given. The data obtained are tabulated. (INIS)

15374 (NIIAR-P-113) KINETICS AND MECHANISM OF NEPTUNIUM(V) REACTION WITH PEROXIDISULPHATE IONS IN NITRATE SOLUTIONS. Timofeev, G. A.; Chistyakov, V. M.; Ermakov, V. A.; Rykov, A. G. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 16p. (In Russian). INIS.

The kinetics of the oxidation of Np(V) by persulfate ions were studied in 0.02 to 1.3 M HNO_3 solutions, while the concentration of $S_2O_8^{2-}$ ranged from 0.1 to 0.4 M, with a temperature range of 24 to 64°C. The reaction rate equation assumed the form: $-\alpha[Np(V)]\,dt = (2K_1 + 2K_6[Np(V)])[S_2O_8^{2-}]$, where K_1 is the rate constant for the non-catalytic path of the thermal decomposition of the $S_2O_8^{2-}$ ions, and K_6 is the rate constant for the direct reaction of Np(V) with persulfate ions. (tr-auth)

15375 (ORO-3621-19) CHELATION AND OLATION REACTIONS OF METAL IONS IN AQUEOUS SOLUTION. Final Report. Martell, A. E. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry). 15 Jun 1973. Contract AT(40-1)-3621. 7p. Dep. NTIS $3.00.

A summary of work performed during a five-year contract period is presented. Four areas of general study include the chelation and olation of metal ions, new multidentate ligands, mixed ligand chelates, and the structure determination of metal chelates in solution. Papers that have been published are listed. (JGB)

15376 EVALUATION OF FORCE CONSTANTS AND CALCULATION OF THE NORMAL VIBRATIONS OF THE URANYL ACETATE COMPLEX ION $[UO_2(COOCH_3)_3]$. Fang Ting K'en; Kovrikov, A. B.; Komyak, A. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 88-93 (1973). (In Russian).

The force constant of the U-ligand bond in $[UO_2(COOCH_3)_3]^-$ was evaluated by Gord's formula. The force constants of the U–O bond in uranyl and the interactions between these bonds corresponding to the characteristic frequencies were calculated with the aid of secular equations. Calculation of frequencies and the form of normal vibrations of the anion complex of uranyl acetate was conducted with the use of a simplified model of the molecule $[UO_2(COOX)_3]^-$, where $X = CH_3$. The calculated frequencies were found to be in good agreement with experimental values. (tr-auth).

15377 HYDROLYSIS OF THE UO_2^{2+} ION IN PERCHLORIC ACID MEDIUM. Mavrodin-Tarabic, M. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 18: No. 4, 609-621 (Apr 1973). (In French).

The nature of the ionic species formed by the hydrolysis of uranium(VI) was determined by the method of the "function of formation" and the method "core + links." It was concluded that, up to a pH of 2.5, the only ion of uranium(VI) that is formed in the solution is UO_2^{2+}, and that at values of the pH > 2.5 the UO_2^{2+} ion hydrolyzes by a series of reactions that lead, even in very dilute solutions, to the formation of polynuclear complexes of the "core + links" type that are characterized by the general formula $UO_2[(OH)_2UO_2]_n^{2+}$. (tr-auth)

15378 NEW THORIUM COMPLEXES WITH PYRIMIDINE DERIVATIVES. Popea, F.; Marculescu, C. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 18: No. 3, 425-430 (Mar 1973).

New thorium compounds of the $ML_4 \cdot nH_2O$ type (M = Th; L = barbituric or thiobarbituric acid), their chemical analyses, thermal behavior, x-ray diffraction data, reflectance and ir spectra, are reported. (auth)

15379 PMR SPECTRA OF URANOMOLYBDIC HETEROACID. Golubev, A. M.; Kazanskii, L. P.; Chuvaev, B. F.; Torchenkova, E. A.; Spitsyn, V. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 209: No. 6, 1350-1342(21 Apr 1973). (In Russian).

The dehydration and PMR spectra of uranomolybdic acid $H_8[UMo_{12}O_{42}] \cdot 18\ H_2O$, were studied, and the following stages of residual water in the molecule were noted: 10, 6.5, 5, 2, and 0.5 H_2O. PMR peaks observed for $H_8[UMo_{12}O_{42}] \cdot 18\ H_2O$ resembled closely those for $H_8[CeMo_{12}O_{42}] \cdot 18\ H_2O$ and $H_8[ThMo_{12}O_{42}] \cdot 18\ H_2O$. (KSW)

15380 CONCENTRATION DEPENDENCE OF ACTIVITY COEFFICIENTS IN THE SYSTEM $KCl-ThCl_4$. Smirnov, M. V.; Kudyakov, V. Ya.; Khudolozhkin, V. N. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 41-43(1972). (In Russian).

The temperature and concentration dependencies of the activity coefficients in the $KCl-ThCl_4$ system were determined from tensimetric measurements over the temperature range 1050 to 1250°K. (KSW)

15381 DETERMINATION OF THE PARTIAL PRESSURE OF URANIUM HEXAFLUORIDE BY MEASURING THE NATURAL RADIOACTIVITY OF URANIUM. Brust, R.; Schroeder, F.; Koske, P.; Martin, H. (Univ., Kiel). Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). vp. (In German).

From reactor meeting; Karlsruhe, Germany (10 Apr 1973).

The suitability of α- and γ-counting of natural uranium for the determination of the UF_6 partial pressure in impure ($-HF-$) UF_6 or UF_6 mixed with He or H_2 was studied. It is shown that both methods are basically applicable, nevertheless, α-counting is more favorable for the lower partial pressures, γ-counting for the higher ones. (GE)

15382 THIOCYANATO COMPLEXES OF TECHNETIUM(IV) AND (V). Schwochau, K.; Astheimer, L.; Schenk, H. J. (Kernforschungsanlage, Juelich, Ger.). J. Inorg. Nucl. Chem.; 35: No. 7, 2249-2257(Jul 1973).

The complex anions $[Tc^{IV}(NCS)_6]^{2-}$ and $[Tc^{V}(NCS)_6]^{-}$ are prepared and isolated as $[(CH_3)_4N]$-salts. They form a redox system the potential of which is found to be $E^{\circ}_{25°C}$ = +0.53 V in 1 M H_2SO_4. Ir spectra indicate nitrogen bonding. Electronic spectra exhibit strong metal reduction bands. According to conductance measurements the d^2 complex proves to be considerably more stable. $[(CH_3)_4N]$ $[Tc(NCS)_6]$ crystallizes in the rhombohedral system with cell dimensions of a = 8.84 Å and α = 82°56′; the magnetic moment of $\mu^{298°K}_{eff}$ = 2.65 B.M. suggests a trigonal stretching of the ligand framework. (auth)

15383 URANIUM OXYSULFIDE AND THORIUM DISULFIDE FROM ORGANIC EXTRACTS OF THIOCYANATES IN AQUEOUS SOLUTION. Ishimori, T.; Ueno, K.; Akatsu, E. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 95-100(Feb 1973).

Uranium oxysulfide was prepared from 1-pentanol extract of uranium(VI) thiocyanate by vacuum distillation and calcination of the distillation residue. Thorium disulfide was similarly prepared from thorium thiocyanate complex in aqueous phase. (auth)

15384 INCORPORATION OF HIGH ENERGY TRITIUM ATOMS IN CYCLIC UNSATURATED HYDROCARBONS. Reichen, W. Diss. Nr. 4731. Zurich; Eidgenoessische Technische Hochschule (1971). 80p. (In German).

Thesis.

On cis-cyclooctene and trans-cyclodecene, the intramolecular distribution of tritium was studied. The tritium originated from the $^7Li(n,\alpha)^3H$ reaction by irradiating with slow neutrons the finely pulverized lithium carbonate contained in the substrate. The influence of thermal substitution of tritium was determined through parallel experiments in which boron oxide was used instead of lithium carbonate. The irradiation then yielded the $^{10}B(n,\alpha)^7Li$ reaction, while the tritium was added in the form of labeled anthracene. The results are discussed in detail, especially with respect to the central rings. (HBG)

15385 VOLATILITY OF COMPONENTS OF MOLTEN KCl–$ThCl_4$ SYSTEMS. Smirnov, M. V.; Kudyakov, V. Ya.; Khudolozhkin, V. N.; Sherstobitova, I. A. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 33-40(1972). (In Russian).

The volatility of saturated vapors of KCl and $ThCl_4$ which contained 0 to 50 mole % $ThCl_4$ was measured over the interval 690 to 990°C, and the composition of the gaseous phase was determined as a function of the composition of the liquid phase. It was proposed on the basis of these data that an equilibrium concentration of the binary compound K_2ThCl_6 existed in the gaseous phase. (tr-auth)

15386 EQUILIBRIA OF METALLIC THORIUM WITH MOLTEN ALKALI METAL CHLORIDES CONTAINING ITS ION. Smirnov, M. V.; Kudyakov, V. Ya.; Posokhin, Yu. V.; Krasnov, Yu. N. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 27-32(1972). (In Russian).

It was shown by equilibrium electrode potential measurements of Th in fused chlorides of alkali metals that metallic Th reduces Th^{4+} to Th^{2+}; the K_{eq} of the reaction Th^{4+}(molten) + Th(s) ⇌ 2 Th^{2+}(molten) was determined. The standard electrode potentials for Th^{4+}/Th and Th^{2+}/Th were measured at functions of the temperature between 675 and 975°C. The influence on these measurements of the nature of the salt-solvent was studied, and empirical equations were developed which related some of these factors. (tr-auth)

15387 SYNTHESIS OF THREE ^{14}C-LABELLED PHENANTHRENE AMINOMETHANOLS. Chien, P. L.; Cheng, C. C. (Midwest Research Inst., Kansas City, MO). Mikrochim. Acta; No. 3, 401-412(1973).

Synthetic procedures for the hydrochlorides of ^{14}C-labeled 3,6-dichloro-α-(2-piperidyl)-9-phenanthrenemethanol, 3,6-dichloro-α-(dibutylaminomethyl)-9-phenanthrenemethanol, and 3,6-dichloro-α-(diheptylaminomethyl)-9-phenanthrenemethanol are described. Radiochemical assay of these compounds is also reported. (auth)

15388 STABILITY CONSTANTS OF DIPHENYLAMINE-2,2′ DICARBOXYLIC ACID CHELATES WITH UO_2(VI), ZrO(IV), VO(IV), AND Mg(II). Mohan Das, P. N.; Sunar, O. P.; Trivedi, C. P. (Univ. of Jodhpur, India). Indian J. Chem.; 2: No. 1, 69-70(Jan 1973).

Diphenylamine-2,2′-dicarboxylic acid (DPDC) forms 1:2 chelates with UO_2(VI), ZrO(IV), VO(IV), and magnesium(II) as revealed by Bjerrum–Calvin pH-titration technique. The stability constants of these metal complexes were determined in 50% (v/v) ethanol–water medium at 25° ± 0.1°C and at μ = 0.2M ($NaClO_4$). (auth)

15389 L-ABSORPTION SPECTRA OF SOME URANIUM AND MERCURY COMPLEXES WITH THIOPROPIONIC ACID AND OF URANIUM COMPLEX WITH THIOMALIC ACID. Nigam, H. L.; Srivastava, U. C.; Pandeya, K. B. (Univ. of Allahabad, India). Indian J. Chem.; 2: No. 1, 62-63(Jan 1973).

L_{III} absorption edges of uranium in UO_2(II) complexes of thiopropionic acid and thiomalic acid, and L_{II} and L_{III} edges of mercury in Hg(II)-thiopropionic acid complex were investigated. The edge-structures were found to agree with the coordination symmetry suggested for the complexes. The results obey the edge-width-coordination stoichiometry relationships $[\Sigma(\chi_M \sim \chi_L) \cdot \text{Edge-width}]^{\frac{1}{4}}$ = constant. (auth)

15390 Fe(II), Co(II), Ni(II), Cu(II), Zn(II), Pd(II), Cd(II), AND UO_2(II) COMPLEXES OF TRIDENTATE SCHIFF BASES. Mehta, R. K.; Gupta, R. K. (Univ. of Jodhpur, India). Indian J. Chem.; 2: No. 1, 56-58(Jan 1973).

N-acetylacetone-β-alanine and N-acetylacetoneanthranilic acid Schiff bases form 1:1 complexes with Fe(II), Co(II), Ni(II), Cu(II), Zn(II), Pd(II), Cd(II), and UO_2(II). All these complexes, except the Cu(II) complexes, exist as monomers in the solid state. This anomalous behavior of Cu(II) complexes which exist as dimers may be due to a nonplanar bridged structure involving the two cupric ions at the opposite ends of an eight-membered ring thereby preventing direct spin-exchange. The presence of the nitrogen atom of the azomethine group in β-position to the carboxylic group is responsible for the general similarity in the behavior of the complexes of the two Schiff bases. (auth)

15391 SALTS OF METAL IONS WITH ORGANIC ARSONIC ACIDS. Part II. Salts of Uranyl Ion With Phenylarsonic Acid and Its Homologues. Sandhu, S. S.; Aulakh, G. S. (Punjab Univ., Patiala, India). Indian J. Chem.; 2: No. 1, 46-48(Jan 1973).

Salts of the uranyl ion with phenylarsonic acid and some of its derivatives were prepared and characterized by elemental analysis and ir spectra. The arsonic acid group acts as a tridentate ligand in these complexes. Ir data also indicate that during coordination of phenylarsonic acids the linearity of the uranyl ion is disturbed. On the basis of their high melting points and negligible solubility in most of the common organic solvents, a polymeric structure is proposed for them. (auth)

15392 PHYSICO-CHEMICAL STUDIES ON THORIUM PEROXOSULPHATE. Raman, V.; Jere, G. V. (Indian Inst. of Tech., New Delhi). Indian J. Chem.; 2: No. 1, 31-34(Jan 1973).

The structural features of thorium peroxosulphate, $Th(O_2)SO_4 \cdot 3H_2O$, are examined on the basis of ir, DTA, and TGA studies. The peroxo group is stable and of the bridging type. The sulphate group is bidentate chelating (C_{2v}). Two water molecules are coordinated to thorium and are tenaciously held. A tentative structure is proposed, and the compound is designated as di-μ-diperoxodisulphatotetraaquodithorium (IV) dihydrate. (auth)

15393 4-ACYL-SUBSTITUTED 1-PHENYL-3-METHYL-PYRAZOLONES-5 AS CHELATING AGENTS FOR ACTINIDE IONS. Bacher, W.; Keller, C. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 35: No. 8, 2945-2956(Aug 1973). (In German).

Various actinide ions M^{n+} (Ac^{3+}, Th^{4+}, UO_2^{2+}, Am^{3+}, Cm^{3+}, Cf^{3+}) are extracted from aqueous solution as their chelates with 1-phenyl-3-methyl-4-acylpyrazoline-5-one (acyl = benzoyl, acetyl, chloroacetyl, trichloroacetyl, trifluoroacetyl). The $pH_{\frac{1}{2}}$-values for the extractions are determined as well as the stability constants β_n and the extraction K_{ex} of the metal chelates. The most stable complexes are formed with 1-phenyl-3-methyl-4-benzoyl-pyrazoline-5-one (HPMBP), e.g., log β_3 = 11.58 ± 0.03 for Ac^{3+}, log β_3 = 17.78 ± 0.12 for Cf^{3+}, and log β_2 = 12.85 ± 0.03 for UO_2^{2+} (μ = 0.1; T = 25°C). Synergistic effects are observed when some organic compounds (e.g. TBP, TOPO, methyl isobutyl ketone) are added to the extraction system Am^{3+}/HPMBP/$CHCl_3$. The stability constants of the extracted adduct chelates are lower than those obtained in synergistic extractions of Am^{3+}–thenoyltrifluoracetone adduct chelates. Spectrophotometric titration of pentavalent neptunium with 1-phenyl-3-methyl-4-acetylpyrazoline-5-one (HPMAP) shows the formation of 1:1 and 1:2 chelates. Their stability constants are: log β_1 = 2.42 ± 0.08 and log β_2 = 4.69 ± 0.82 (μ = 0.1; T = 25°C). (auth)

15394 REACTION OF URANIUM(IV) AND THORIUM(IV) WITH PYROCATECHOL VIOLET. Chiacchierini, E. (Univ., Rome); Gocchieri, R.; Sommer, L. Collect. Czech. Chem. Commun.; 38: No. 5, 1478-1496(May 1973).

The equilibria of UO_2^{2+} and Th^{4+} with pyrocatechol violet were studied spectrophotometrically. Various mononuclear and dinuclear complexes of both metal ions are formed in solutions in

dependence on the acidity and concentration of components. The spectrophotometric characteristics and equilibrium constants for various species were calculated. (auth)

15395 STUDY OF THE URANATE HYDRATES. 2. The Vibrational Properties of the Hydrated Uranates of Bivalent Cations. Sobry, R. (Univ., Liege). J. Inorg. Nucl. Chem.; 35: No. 8, 2753-2768(Aug 1973). (In French).

An attribution of the Raman and ir frequencies is proposed for some hydrated uranates of general formula $mXO \cdot 2UO_3 \cdot (4 \text{ to } 2m)\ H_2O$ ($0 \leq m < 2$; X = Ca, Sr, Pb, Ba). Symmetrical and antisymmetrical vibrations of uranyl ions are principally affected by m and are nearly independent from the nature of X^{2+}. The observed frequencies indicate an uranium–oxygen distance included between 1.70 and 1.78 Å. For $UO_3 \cdot 2H_2O$, two distinguishable uranyl ions are observed. The ir spectra can be explained with oxonium and hydroxyl ions as suggested by Brasseur. The dehydration study confirms the mechanism proposed and suggests the general formula: $X_m[(UO_2)O_m(OH)_{2-m}]_2$ ($m \neq 0$) for partially dehydrated uranates. For $UO_3 \cdot 2H_2O$, a double mechanism occurs in the first dehydration step and the well known compound $UO_3 \cdot 0.7$ to $0.8\ H_2O$ must be written $(UO_2)O(OH)_6$. Subsequent dehydrations imply a modification of uranyl coordination and further a replacement of the uranyl ions by chains U–O–U–O. The comparison of the spectra obtained from various preparations of $UO_3 \cdot 2H_2O$ suggests the existence of only one synthetic crystallographic form of this compound. (auth)

15396 PREPARATION, PROPERTIES, AND MOLECULAR STRUCTURE OF BIS(PROTONATED THIAMINE-TETRACHLORODIOXOURANIUM(6)). Marzotto, A.; Bandoli, G.; Clemente, D. A.; Benetollo, F.; Galzigna, L. (Consiglio Nazionale delle Richerche, Padua). J. Inorg. Nucl. Chem.; 35: No. 8, 2769-2774(Aug 1973).

The reaction product between $UO_2Cl_2 \cdot 3H_2O$ and thiamine hydrochloride (thiaminium dichloride) was characterized as bis(protonated thiamine) tetrachlorodioxouranium(VI) ($[C_{12}H_{18}ClN_4OS]_2 UO_2Cl_4$) by physico-chemical measurements including x-ray structure determination. The crystals are monoclinic with unit cell parameters a = 11.199, b = 6.968, c = 23.675 Å; $\beta = 97.50°$. The space group is $P2_1/n$ and there are two molecules of compound per cell. The structural data in the thiamine molecule are not significantly different from those reported for thiamine hydrochloride; the symmetry of the $[UO_2Cl_4]^{2-}$ ion is very close to $4/mmm(D_{4h})$. The U–Cl distances are in the range 2.66 to 2.69 Å. The research is part of a study aiming to clarify the cause of the inhibitory effect of uranyl ion on neutral transmission. (auth)

15397 URANYL CHEMILUMINESCENCE EXCITED BY OZONE IN CONCENTRATED SULFURIC ACID. Parshin, G. S.; Bulgakov, R. G.; Kazakov, V. P.; Dmitrieva, E. V. High Energy Chem. (USSR) (Engl. Transl.); 6: No. 6, 438-441(1972).

Translated from Khim. Vys. Energ.; 6: No. 6, 498-501(1972).

The chemiluminescence (CL) of UO_2^{2+} solutions excited by ozone in concentrated sulfuric acid was studied. The chemiluminescence is connected with the decomposition of ozone on reaction vessel walls. It was demonstrated that the uranyl ions do not catalyze O_3 decomposition. By determining the spectral region of luminescence, it was concluded that oxygen and uranyl behave as CL emitters. It was found that the processes responsible for luminescence are strongly influenced by the reaction vessel walls. (auth)

15398 TRITIUM LABELED MOLECULES. Preparation, Quality Control, Conservation. Pichat, L. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 178, 73-77(Feb 1973). (In French).

The advantages and disadvantages of tritium labeled molecules compared with ^{14}C labeled molecules are briefly reviewed. The various methods of preparing tritiated molecules are discussed. Emphasis is given to recent work of the Labeled Molecules Service. A self-decomposition of the tritiated product occurs as a result of its own radiation. This radiolysis necessitates the frequent checking of the quality of the products. (FR)

15399 COMPARATIVE STUDY OF THE ABSORPTION SPECTRA OF URANYL HALIDES. Complexes Having the Following Symmetries D_{4h}^1, D_{4h}^3, D_{4h}^4, and D_{4h}^5. Goerller-Walrand, C.; de Jaegere, S. (Univ., Louvain, Belgium). J. Chim. Phys.; 70: No. 2, 360-366(Feb 1973). (In French).

The absorption spectra of uranyl complexes with monodentate ligands (Br^-, Cl^-, F^-) were obtained both in solution and in the solid state. In order to define the electronic transitions in the spectra, two criteria are considered: the mirror image relation; the effect of stepwise complexing. It is shown that the symmetry and coordination number of the complexes determine their electronic behavior. A spectrochemical series is obtained for the ligands on the basis of the values of the symmetrical frequencies of vibration ν_s of the uranyl radical. (FR)

15400 STUDIES ON ACTINOID ELEMENTS. 5. Determination of the Np(V)/Np(IV) Radio in an Aqueous Solution by Means of the Partition Method. Ohyoshi, A.; Kawamura, T. (Kumamoto Univ., Japan). Bull. Chem. Soc. Jap.; 46: No. 1, 162-165(Jan 1973).

The distribution study of neptunium ions in an aqueous solution containing Np(IV) and Np(V) was made using the metal chelate extraction system, TTA–benzene, or HDEHP–benzene at room temperature. The results obtained by this method were then compared with those obtained by spectrophotometry. In each system, a linear relationship was obtained between the fraction of the Np(V) ion and $1/(D + 1)$, where D is the distribution ratio of neptunium. This analysis was performed with an accuracy of ±5% and was established within one minute in the case of the HDEHP–benzene system. The results obtained by this method were in good agreement with those obtained by spectrophotometry. (auth)

Radioactive Waste Treatment

Refer also to abstracts 15476 and 16148.

15401 (CEA-R-4444) COATING OF ALUMINUM RESIDUES CONTAINING FISSION-PRODUCT FLUORIDES. Labe, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1973. 106p. Dep. NTIS (U. S. Sales Only) $7.50.

The treatment of high level wastes is studied in the case of the alumina beds coming from the reprocessing of irradiated fuel by fluoride volatility process. The tested method consists of coating the wastes with glass; the resulting dense blocks present many advantages when compared to the initial wastes, including a reduced volume and the prospect of safer handling. Experiments were carried out to determine the volatility of different fission products fluorides and the convenient compositions of glass. (auth)

15402 (RFP-2004-A) CHEMISTRY RESEARCH AND DEVELOPMENT. Research and Ecology Semiannual Progress Report, July–December 1972. Bright, W. C.; Cartwright, D. R.; Moseley, J. D.; Vejvoda, E. (Dow Chemical U.S.A., Golden, Colo. Rocky Flats Div.). 16 May 1973. Contract AT(29-1)-1106. 32p. Dep. NTIS $4.00.

Short summaries are presented of work in progress in the areas of fabrication of ^{244}Pu metal foil; recovery, storage, and chemistry of plutonium; radioactive waste processing; and radiation monitoring. (DHM)

15403 TREATMENT OF RADIOACTIVE LIQUIDS. Van de Voorde, N. L. C. (to Belgonucleaire SA). U. S. Patent 3,716,490. 13 Feb 1973. Priority Date 11 Dec 1967, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

A method is given for decontamination of radioactive liquids and the products thereof, including contacting the radioactive liquid with an ion exchange material formed from a bituminous substance, such as asphalt, and thereafter compacting the ion exchange material, as by fusion and/or compression. (Official Gazette)

15404 TREATMENT AND STORAGE OF RADIOACTIVE WASTE. Hepp, H. (Preussische Elektrizitaets AG, Wuergassen, Ger.). (1973). vp (In German).

From VGB conference: power plant and environment, 1973; Essen, Germany (27 Feb 1973).

The generation of radioactive wastes is explained, particularly the waste situation in nuclear power plants is described. The methods applicable for liquid waste processing, solidification of residues from sewage decontamination, as well as the treatment of radioactive solid and gaseous wastes are briefly outlined. The waste processing in reprocessing plants is also discussed. The final waste storage methods as practiced in the FRG are exemplified. The importance of the whole problem is made clear by means of the evaluation of radioactive waste amounts until the year 2000. (GE)

15405 IMPROVEMENTS IN AND RELATING TO DECONTAMINATION PROCESSES FOR RADIO-ACTIVE LIQUIDS. Peeters, K.; van de Voorde, N. (to Belgonucleaire SA). British Patent 1,312,852. 11 Apr 1973. Filed date 1 Sep 1970. 10p.

The method described is stated to be specific for radioactive ions, and to at least partly avoid disadvantages associated with other methods. The liquid is contacted with a mixed sorbent comprising inorganic material composed of at least two compounds of the following group: a Ba salt, a metal sulfide, and Cu ferrocyanide. Ions such as Na, Ca, Mg, Fe, and Al are not extracted.

Sorption may be achieved by formation of mixed crystals, or by precipitation, including coprecipitation and post-precipitation. Of the radioactive ions Sr is preferably sorbed by a Ba salt; Ra and Ce by a Ba salt or a metal sulfide; Ru and Sb by a Ba salt, metal sulfide, or Cu ferrocyanide; Co by a metal sulfide or Cu ferrocyanide; and Cs by Cu ferrocyanide. The Ba salt may be sulphate or carbonate, and the metal sulfide may be iron or manganese sulfide. The process may be used in many different applications. (UK)

Radioisotope Production

Refer also to abstracts 15814 and 15815.

15406 (AE-471) NUCLEAR CHEMISTRY PROGRESS REPORT, 1972. Carleson, G. (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1973. 27p. Dep. NTIS (U. S. Sales Only) $3.50.

A technique was developed to separate radiochemically pure ^{99m}Tc from ^{99}Mo in yields between 50 to 75% by the evaporation of Tc_2O_7 at temperatures below 700°C. The melting point of MoO_3 is depressed by the addition of alkali metal oxides. The apparatus is described. Results of other studies accepted for publication are summarized. References are given. (JGB)

15407 ^{113m}In GENERATOR. Oniciu, I. Stud. Univ. Babes-Bolyai, Ser. Chem.; 17: No. 1, 5-22(1972). (In Rumanian).

A review is presented of the preparation methods, functioning and regeneration characteristics, as well as of the ^{113m}In generator applications. Comparison is made of ^{113m}In and ^{99m}Tc usage. (DHM)

15408 DRY DISTILLATION OF IODINE-131 FROM SEVERAL TELLURIUM COMPOUNDS. Shikata, E.; Amano, H. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 80-88(Feb 1973).

Several Te compounds including a new Te oxide Te_5O_{11} were subjected to dry-distillation after reactor irradiation in order to overcome the difficulties accompanying the ordinary dry-distillation from TeO_2. The release of ^{131}I from Te_5O_{11} was examined as function of distillation temperature and the thermal behavior of ^{131}I released was studied by means of thermochromatography. For comparison, the ^{131}I release from other Te compounds such as H_6TeO_6, $(H_2TeO_4)_n$, and TeO_3 was also studied. The compounds studied were found to release ^{131}I rapidly at temperatures lower than employed in the ordinary dry-distillation of ^{131}I from TeO_2, thus obviating all risk of contaminating the final products with Te vaporizing at higher temperatures. The rapid release of ^{131}I was concluded to be caused by thermal decomposition of the compounds studied. In an attempt to prepare a "dry source" of ^{131}I, ^{131}I dry-distilled from Te_5O_{11} was adsorbed on Molecular Sieve, and the release of ^{131}I from the Molecular Sieve was similarly studied. (auth)

15409 RELEASE OF CARBON-14 FROM NEUTRON-IRRADIATED ALUMINUM NITRIDE IN THE DRY PROCEDURE. Hata, K.; Shikata, E.; Amano, H. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 2, 89-94(Feb 1973).

The dry procedure was applied to the separation of ^{14}C from either finely powdered AlN or AlN in tablet form after neutron irradiation. The mechanism of the ^{14}C release from the irradiated materials was studied, and the possibility of using AlN target in tablet form for routine production of ^{14}C was examined. Powdery AlN, sintered powder tablet, molded powder tablet, and sintered mold tablet were irradiated for 12 days in the JRR-2 reactor. After irradiation, ^{14}C was separated in the form either of dioxide or of monoxide, from the irradiated material at various temperatures under oxygen stream and the rate of combustion of AlN and that of the ^{14}C release were determined as a function of temperature and reaction time. The release of ^{14}C from neutron irradiated AlN was found to accompany the oxidation of AlN which took place in the form of tarnishing reaction. Above 1,090°C, the release of ^{14}C obeyed the logarithmic rule, indicating that it is governed by the migration of ^{14}C in the oxide layer. The chemical yield of ^{14}C was almost 100%, when powdery AlN was heated for 5 hr at 1,180°C. The yield deteriorated in the sequence of sintered powder–molded powder–sintered mold tablet, the last mentioned form producing a yield of only 50% yield under the same conditions. (auth)

15410 TRITIUM PRODUCTION IN FRANCE. Hugony, P. (Centre de Marcoule, Bagnols-sur-Ceze, France); Sauvage, H.; Roth, E. Bull. Inform. Sci. Tech. (Paris); No. 178, 3-17(Feb 1973). (In French).

Most of the tritium producing facilities in France are found at Marcoule: the two Celestin reactors and the tritium extraction and purification plant. The two heavy water reactors started up in 1967 and 1968 are fed with plutonium or enriched uranium. The standard type of element irradiated is an enriched lithium target in which the following reaction takes place: lithium 6 + neutron → helium 4 + tritium. After a given period of irradiation, these targets are unloaded and transferred to the processing plant; the tritium is extracted by fusion, purified, and finally subjected to thermal diffusion process in which almost all the traces of hydrogen and deuterium are removed. Another plant exists at Grenoble for recovering the tritium formed in the heavy water of the high flux reactor of the Laue Langevin Institute. (FR)

Reactor Fuel Reprocessing

Refer also to abstracts 15202 and 17432.

15411 (DOCKET-50332-31) BARNWELL NUCLEAR FUEL PLANT. Preliminary Safety Analysis Report, Amendment 6. (Allied-Gulf Nuclear Services, Barnwell, S.C.). 2 Jul 1973. 6p. Dep. NTIS $3.00.

The Application for a Construction Permit and Operating License is amended to include construction of facilities for conversion of plutonium nitrate to plutonium oxide and for storage of latter. (DHM)

15412 (DOCKET-50332-32) BARNWELL NUCLEAR FUEL PLANT. Preliminary Safety Analysis Report, Addendum 7. (Allied-Gulf Nuclear Services, Barnwell, S.C.). 2 July 1973. 234p. Dep. NTIS $13.75.

The method is presented by which Allied-Gulf Nuclear Services will augment the Separations Facility of the Barnwell Nuclear Fuel Plant (BNFP) to include the necessary capability to convert plutonium nitrate to plutonium oxide and to provide storage for plutonium oxide product and directly related activities. (DHM)

15413 (ORNL-4832, pp 157-185) PART 4. FUEL PROCESSING FOR MOLTEN-SALT REACTORS. McNeese, L. E. Mar 1973. Molten-Salt Reactor Program Semiannual Progress Report for Period Ending August 31, 1972.

Research progress on processes for the isolation of Pa and the removal of fission products from molten-salt breeder reactors is reported. Studies of equilibria in fused salt–liquid alloy systems were continued. The solubility of Li_3Bi in molten LiCl was found to be about the same as that reported for LiCl–LiF (70:30 mole %); the molar ratio of free Li to Bi in the salt phase is 3. Li and Bi were found to distribute between liquid Li–Bi alloys and LiBr or LiF in a manner similar to that with LiCl. Experiments were conducted to determine whether Pb could be substituted for Bi in any part of the metal transfer process. Measurements of the solubility of Th in Li–Pb alloys indicate that Li–Pb alloys could be substituted for Li–Bi alloys in the contactor where divalent rare earths are removed from the LiCl. The reductive–extraction behavior of Ti, a component of modified Hastelloy N, was studied. Studies of the chemistry of fuel reconstitution were continued. Spectrophotometric evidence showed conclusively that UF_5 is the product of the reaction of gaseous UF_6 with UF_4 dissolved in MSBR fuel salt. Further progress was made in studying the equilibrium precipitation of Pa from LiF–BeF_2–ThF_4 (72:16:12 mole %) by sparging the salt with HF–H_2O–Ar gas mixtures. The purification and charging of the salt and metal phases to metal transfer experiment MTE-3 were completed, and operation of the experiment was initiated in order to measure the rate at which rare earths transfer through the system. Mass transfer coefficients for ^{228}Ra were in good agreement with those correlated from the literature; those for Eu and La were lower than predicted. Experiments were carried out to measure mass transfer rates in simulated mechanically agitated salt–metal contactors. The rate of extraction of Pb from an aqueous phase containing $PbNO_3$ into Hg containing Zn at low concentrations indicate that the mass transfer coefficients in a water–mercury system are predicted reasonably well by an existing correlation that is based on mass transfer in aqueous organic systems. Further studies were performed in the mild steel reductive-extraction system in which the rates of transfer of ^{97}Zr and ^{237}U from molten salt to Bi in a packed column were measured. Data indicate that the height of an overall transfer coefficient based on the Bi phase is about 4.3 ft for extraction factors near unity, and that the mass transfer performance of packed columns is adequate for their use in processing systems. The feasibility of flaring commercially available Mo tubing was demonstrated, and several types of flare fittings made of Mo were designed and fabricated. (JGB)

15414 (ORNL-TM-4240) AQUEOUS FUEL REPROCESSING QUARTERLY REPORT FOR PERIOD ENDING MARCH 31, 1973.

Unger, W. E.; Blanco, R. E.; Crouse, D. J.; Irvine, A. R.; Watson, C. D. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 39p. Dep. NTIS $4.00.

Highlights from the aqueous fuel reprocessing quarterly report are: (1) Dowtherm A was found to be very effective in transporting heat inside simulated single-assembly LMFBR shipping casks. (2) In tests with short-cooled high-burnup fuel, essentially complete (>99.95%) dissolution of the plutonium was obtained in 6 hr by adding 0.05 M Ce(III) to the 8 M HNO_3 dissolver solution. (3) The rate of dissolution of UO_2 from sheared fuel end pieces is strongly affected by their orientation in the solution. (4) The efficiency in scrubbing iodine from gas streams with mercuric nitrate solutions was greatly decreased when aromatic organic vapors were added to the system. (auth)

15415 BARNWELL NUCLEAR FUEL PLANT. Com. Naz. Energ. Nucl., Notiz.; 19: No. 3, 91-93(Mar 1973). (In Italian).

A description is given of the fuel-reprocessing plant which Allied Gulf has built at Barnwell, South Carolina. This 5-ton/year plant should be ready for one year of cold operation around mid-1973 and begin commercial operations around 1974. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 17652.

15416 (AD-757771) HIGH-ENTHALPY EXTRACTION EXPERIMENTS IN A LARGE NONEQUILIBRIUM MHD GENERATOR. Zauderer, B.; Tate, E. (General Electric Co., Philadelphia, PA. Space Div.). Mar 1973. Contract N00014-73-C-0039. 11p. NTIS.

Some experiments in a shock tunnel driven-MHD generator which was designed to achieve enthalpy extractions of up to 20% are reported. The MHD channel design changes consisted in doubling the area ratio to 6, increasing the length to 1.5 m increasing the peak magnetic field strength to 4 Tesla. To date, up to 1200 kW, representing 12.6% enthalpy extraction, have been obtained in cesium seeded neon at 347°K and 2.2 Tesla. The power output was uniformly distributed along the entire channel length. Analyses of the gas dynamic data showed that, unlike the previous generators, the present generator has not reached choking conditions at the maximum enthalpy extraction. Thus, extension of the present experiments to higher magnetic fields should yield considerably higher enthalpy extractions. (auth)

15417 (AEC-tr-7432) SHORT COURSE ON THERMOELECTRIC DEVICES AND THEIR APPLICATIONS. Kolomoetz, N. V. [nd]. Translation of Lecture Notes. 30p. Dep. NTIS $3.50.

Lecture notes for a course on thermoelectric devices and their uses are presented. The notes discuss low-, medium-, and high-temperature thermopiles, procedures for measuring thermoelectric properties, and problems in increasing the efficiency of thermoelectric materials. (TFD)

15418 (ARCO-3057-12) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Quarterly Progress Report, February 1, 1973–April 30, 1973. (Arco Nuclear Co., Leechburg, Pa.). Aug 1973. Contract AT(11-1)-3057. 22p. Dep. NTIS $5.45.

Progress is reported on the development of a radioisotope-powered cardiac pacemaker. The developmental work is discussed under the following tasks: program management, control and planning; reliability and quality assurance; system fabrication and production development; system testing; and safety. (RCK)

15419 (LA-5295-MS) PRELIMINARY STUDY OF OPEN-CYCLE SPACE POWER SYSTEMS. Booth, L. A.; Hedstrom, J. C. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 17p. Dep. NTIS $4.00.

Specific masses of earth-orbiting electric power systems in the tens-of-megawatts range with lifetimes of a few hours are estimated. With the low total energy requirement corresponding to short operating times, open-cycle systems, consisting of a disposable working fluid and a heat-engine power-conversion system, were chosen for study. Results indicate that open-cycle system masses are lower than optimistic projections of closed-cycle-system masses for operating times up to ~10^4 s. (auth)

15420 (TID-26342) Si–Au SCHOTTKY BARRIER NUCLEAR BATTERY. Tse, A. N. (Dartmouth Coll., Hanover, N. H. Thayer School of Engineering). Nov 1972. 168p. Dep. NTIS $7.60.

Thesis.

A long-life, high-power-density, high-reliability, compact microwatt battery is needed in many applications. In the field of medicine, for example, such a battery could power an artificial pacemaker which would greatly extend the residence time of the device. Various alternatives are analyzed and discussed. Betavoltaic conversion systems with Si–Au Schottky barrier cells coupled with ^{147}Pm metal foil were selected for investigation. Characterization experiments were performed to obtain optimized silicon resistivity and promethium metal foil thickness. Radiation dose rates were measured and the safety aspects of the battery were analyzed. A prototype battery was assembled and tested. The economics of the battery were demonstrated for special applications. It is concluded that a microwatt nuclear battery can be built with a conversion efficiency of 1 to 2%, a power density of 60 to 300 $\mu W/cm^3$ depending on the power level, and a useful life of 5 to 10 years. Further research areas are recommended. (auth)

15421 THERMIONIC CONVERTER. Janner, K.; Pehs, M. (to Siemens AG). German Patent 1,614,414. 16 Jul 1970. Filed Date 28 Jan 1967. (In German).

A thermionic converter is described in which the body of the cathode contains nuclear fuel and an apparatus for the evacuation of gases of dissociation from the combustion chamber characterized by a conduit for the dissociation gas leading into a channel in the fuel; the diameter of the dissociation gas conduit, especially at the opening of the combustion chamber is chosen so that the condensed fuel is just sufficient to heat the opening by nuclear fission and that the diameter of the conduit that remains available serves for the evacuation of the fission gases. (TSS)

15422 UNIFORM IONIZATION MEANS FOR MHD GENERATORS. Zauderer, B. (to General Electric Co.). U. S. Patent 3,736,447. 29 May 1973. Filed Date 27 Sep 1971. 10p.

Temperature limitations imposed by available materials require provision of other than purely thermal means for ionizing the gas used in hot-gas magnetohydrodynamic (MHD) generators. Efficiency of such generators is markedly reduced by non-uniform ionization. Prior art ionization methods, even when adequate, require the use of appreciable fraction of length of expensive MHD channel to achieve high and uniform conductivity of the gas plasma. Hot, cesium-seeded partially ionized gas passes through large-diameter conduit from source to nozzle feeding the MHD channel. The magnetic field in the pre-channel nozzle and conduit portions causes current flow in the gas between short-circuited electrode pairs or pairs that are fed repeated short high-voltage pulses continued by longer lower voltage pulses. Such current flow increases ionization everywhere in the gas to desirable high and uniform levels. Alternatively, gas not so seeded is ionized by irradiation from nuclear heat source; or gas not ionized is preionized by discharges between the first pairs of electrodes, and then fully and uniformly ionized by discharges between later pairs of electrodes. (Official Gazette)

15423 PROBLEM OF LOAD FACTOR IN CALCULATIONS OF MHD GENERATORS. Pelz, P. Acta Tech. CSAV; 15: No. 6, 690-705(1970).

A critical study of the introduction of load factors into calculations concerning optimization of operational states of MHD machines, as currently used in the literature, showing inaccuracies is presented. A proposal is made for expressing operation parameters by load resistance and specific conductivity of working fluid, showing advantages. Load factor can be considered more advantageously as relative value of transverse component of electric field intensity; this is helpful in classification of operational modes of MHD devices from viewpoint of electrical machines. For series or parallel operation of MHD generators with external current supply, operating characteristics K = K(P) are proposed (where P signifies the relative electromotive force of external source). With help of these characteristics, the operating regimes of MHD generators can be easily represented, including transition from motor to braking operation. (App. Mech. Rev.)

15424 ELECTRICAL CONDUCTIVITY OF TURBULENT NON-EQUILIBRIUM PLASMA IN MHD GENERATORS. Gay, P.; Zampaglione, V. (CNEN, Frascati, Italy). Energy Convers.; 13: No. 3, 95-101(Jul 1973).

A review and discussion are given of up-to-date theoretical models of the effect of ionization turbulence on the plasma electrical conductivity in the bulk of a non-equilibrium MHD generator. Conductivity calculations based on these models are presented and compared with available generator experimental data, to assess the present accuracy of theoretical predictions about generator power output. The main conclusion is that current calculations, based on an approximate average electron energy balance in the bulk, may lead to a strong overestimation of generator power output. The approach based on the laminar electron temperature equation (which has been recently proposed by one of the authors) makes it possible to predict generator performance much more reliably. For moderate values of the microscopic Hall parameter above the threshold of ionization instability ($\beta_0 \lesssim 4 + 5\beta_{co}$), there is not an adequate description as yet of the behavior of the turbulent electric parameters; therefore, only a coarse prediction (within a factor 2 + 3) can be made about generator power output. For larger values of β_0, the behavior of effective electrical conductivity and Hall parameter observed in the laboratory is well accounted for by proper analytical formulas and the accuracy of theoretical predictions about generator power output is better than 50%. (auth)

Facilities and Equipment

Refer also to abstracts 15799, 15922, 17722, 17805, and 17835.

15425 (BNWL-SA-4529) EXTRACORPOREAL BLOOD IRRADIATOR SOURCE STUDY. Griffin, B. I.; Cross, F. T.

(Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1973. Contract AT(45-1)-1830. 7p. (CONF-730603-5). Dep. NTIS $3.00.

From 18th Health Physics Society meeting; Miami Beach, Florida, USA (17 Jun 1973).

Design criteria for an extracorporeal blood irradiator using $^{90}Sr-^{90}Y$, ^{147}Pm, and/or ^{170}Tm beta sources are described. (TFD)

15426 (COO-1248-35) FLUID MECHANICS OF THE LAMINAR FLOW AEROSOL IMPACTOR. Marple, V. A.; Liu, B. Y. H.; Whitby, K. T. (Minnesota Univ., Minneapolis. Particle Technology Lab.). Mar 1973. 30p. (CONF-730607-2). Dep. NTIS $3.50.

From joint meeting on fluids engineering and applied mechanics divisions; Atlanta, Georgia, USA (20 Jun 1973).

A study has been made of the fluid mechanics of laminar flow aerosol impactors of both the rectangular and round geometry. Streamlines in a rectangular impactor were obtained theoretically by solving the Navier–Stokes equations on a computer. The results were found to be in good agreement with experimentally generated streamlines in a water model using an electrolytic flow visualization technique. Further theoretical studies of the impactor using the computer solution technique showed that the flow field in the impaction region above the impaction plate is influenced only to a very limited extent by the impactor throat length while the effect due to variations in the jet-to-plate distance and the jet Reynolds number is somewhat larger. The boundary layer thickness along the impaction plate was found to be nearly constant, but the thickness was dependent on the jet Reynolds number and affected to a very slight extent by the jet-to-plate distance. (auth)

15427 (RDT-E-9-7-T(5-73)) FANS, BLOWERS, AND COMPRESSORS FOR DRY GAS CIRCULATION. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1973. 26p. RSO.

This standard covers the requirements for construction and delivery of gas movers for the circulation of air or inert, potentially radioactive process gases. Equipment covered by the standard includes axial and centrifugal fans, blowers and compressors having pressure-retaining boundaries (i.e., casings) designed to meet the requirements of Section III of the ASME Boiler and Pressure Vessel Code. (auth)

15428 (TID-26350) TRANSFER OF EXCESS EQUIPMENT TO TPRC. (Purdue Univ., Lafayette, Ind.). [nd]. Contract AT(11-1)-2159. 5p. Dep. NTIS $3.00.

A description of excess equipment transfered from North American Rockwell Corporation to the Thermophysical Properties Research Center (TPRC) for developing a unique apparatus for measuring the thermophysical properties of solid materials is presented. The apparatus is capable of simultaneous or consecutive determinations of ten electrical, thermal and optical properties on the same sample at temperatures up to 2800°K. The method involves passing an electric current through the sample to heat up the central region. The ends of the sample are maintained at room temperature by means of water cooling. From various electrical, thermal, and dimensional measurements made on the sample, electrical resistivity, thermal conductivity, hemispherical total emittance, normal spectral emittance at 0.65 microns, specific heat, enthalpy, thermal diffusivity, thermal expansion, Wiedemann–Franz-Lorenz function, and Thomson coefficient are determined. (TFD)

15429 (Y-SC-75) MACHINING AND GAGING INFORMATION 1972 ANNUAL INDEX. Read, A. M.; Beaver, D. S. (comps.) (Oak Ridge Y-12 Plant, Tenn. (USA)). 20 Jul 1973. Contract W-7405-eng-26. 143p. Dep. NTIS $9.25

This index cites documents that contain information about the high-accuracy, close-tolerance aspects of machining, dimensional measurement and gaging which have been evaluated and announced by the Machining and Gaging Information Center during calendar year 1972. It consists of five sections: a permuted title index, a key word index, an author index, a corporate author index, and a bibliographic section. Each bibliographic entry is arranged according to corporate author and includes a title, personal author, report designation, abstract, report availability, and key word descriptors. (auth)

15430 ALPHA PUMP (6 Apr 1973) (ENGINEERING MATERIALS). (Oak Ridge National Lab., Tenn.). (CAPE-2341). 19 drawings.

An ALPHA pump that is a centrifugal sump pump designed at Oak Ridge National Laboratory for molten salt or liquid metal service is described. The pump will operate at speeds up to 6000 rpm to provide flows to 30 gpm at temperatures to 1400°F. Pump performance data with water are given. The lower liquid wetted portions of the pump are fabricated of Hastelloy N alloy and the bearing housing is fabricated of stainless steel. However, the wetted portions may be fabricated of other metals or alloys compatible with specific process fluids. An auxiliary tank mounted adjacent to and on the same level as the pump bowl provides the necessary space to accommodate thermally created volume changes in liquid inventories and to mount liquid level indicators and liquid sampling equipment. The auxiliary tank may be replaced to accommodate the requirements of a particular experiment. Interconnecting piping between the auxiliary tank, pump bowl, and pump inlet permits liquid leakage from the shaft labyrinth above the impeller to flow into the auxiliary tank and then return to the pump inlet. The liquid flow rate through the auxiliary tank (shaft labyrinth leakage) varies with pump speed and flow rate. (RCK)

Heat Transfer and Fluid Flow

Refer also to abstracts 15971, 17365, 17534, 17648, 17672, 17726–17728, 17733, 17770, 17771, 17803, and 17809.

15431 (AEEW-M-976) QUENCHING OF A HEATED SURFACE BY A FILM OF WATER IN A STEAM ENVIRONMENT AT PRESSURES UP TO 53 BAR. Elliott, D. F.; Rose, P. W. (Atomic Energy Establishment, Winfrith (England)). Jul 1970. 31p. Dep. NTIS (U. S. Sales Only) $3.75.

A series of experiments designed to measure the rate at which a heated surface will re-wet in a steam environment for a range of water flows and in ambient pressures up to 53 bar is described. A description of the experimental rig is given and the results from a series of tests with three different test sections are discussed. The results show that the re-wetting or quench rate depends upon the surface temperature of the test section and the ambient pressure but is independent of the cooling water flow rate. Correlations are given for the calculation of the re-wetting rate in terms of the test section temperature and the ambient pressure. (auth)

15432 (AAEW-R-668) INVESTIGATION INTO THE EFFECTS OF SURFACE COATINGS ON FORCED CONVECTION BURNOUT WITH FREON-11. Kinneir, J. H. (Atomic Energy Establishment, Winfrith (England)). Feb 1970. 26p. Dep. NTIS (U.S. Sales Only) $3.50.

Results of an investigation into the effects on forced convection burnout of covering a heated rod with various textile materials are presented. The work was done at low pressure with Freon-11 flowing vertically upwards through an annulus consisting of a heated tube 3 ft long and $\frac{5}{8}$ in. OD fixed concentrically within a glass tube of 1 in. nominal bore. The object of the work was to support preliminary studies of the effects on boiling of porous deposits such as magnetite (often referred to as crud) that tend to build up on boiling surfaces. The results show that some open-weave materials significantly increase the burnout power. Unusual surface effects were also observed with a close-weave material suggesting that for a "crudded" rod pool boiling characteristics may prevail even though the test-section has forced flow. (auth)

15433 (CEA-CONF-2311) MODELING METHODS IN TWO PHASE FLOW THERMOHYDRAULICS. Boure, J. A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 21p. (CONF-720686-1). Dep. NTIS (U. S. Sales Only) $3.25.

The methods classically used to define scaling factors are discussed. In the present state of knowledge they are not directly applicable to two-phase flows. Several methods have been proposed to overcome the difficulty. One of these is to seek correlations of experimental results which have the same form for the fluid to be molded and for the modeling fluid. Another method is to obtain dimensionless groups from a selected set of parameters and to amend these groups by correction factors. Examples of scaling laws developed by the various methods are given. It is concluded that modeling is in fact of great interest for two-phase flows but that research in this field is still necessary. (auth)

15434 (KFKI-73-12) POOL BOILING CRISIS. Maroti, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar 1973. 16p. Dep. NTIS (U. S. Sales Only) $3.00.

The transition from the simultaneous superheated liquid and latent heat transport of developed nucleate boiling to the purely latent heat transport of transient film boiling is marked by an increase in the heat transfer rate to a maximum. This maximum–the critical heat flux–occurs when the total amount of incoming fluid is just vaporized at the heater surface. The crisis is consequently hydrodynamic in nature. This, it is shown, implies that the critical heat flux can be determined from the conservation

laws for the mass, energy and momentum. Moreover, by taking into account the effect of subcooling in the energy equation, the maximum achievable heat flux can also be determined for subcooled boiling conditions. (auth)

15435 (MRR-P-2) TUMHEX: A COMPUTER CODE FOR THE CALCULATION OF THE FREQUENCY RESPONSE BEHAVIOR OF SHELL-AND-TUBE TYPE COUNTERFLOW HEAT EXCHANGERS WITH RESPECT TO PRIMARY AND SECONDARY INLET TEMPERATURE AND MASS FLOW PERTURBATIONS. Hoeld, A. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Mar 1973. 67p. Dep. NTIS (U. S. Sales Only) $5.50.

A description of the TUMHEX digital code is given. TUMHEX calculates the frequency response behavior of the coolant outlet temperatures and mass flow rates, the coolant and tube wall mean temperatures and heat fluxes on both primary and secondary side of a shell-and-tube type counter-flow heat exchanger with respect to primary and secondary inlet temperature and mass flow perturbations. The code is based on a linear analytical one-dimensional model which was developed under the assumption of temperature-dependent coolant densities, mass flow dependent heat transfer coefficients and (non neglectable) heat conduction through the heat exchanging tube walls. (auth)

15436 STEAM: ITS GENERATION AND USE. New York; Babcock and Wilcox (1972). 463p. $15.00.

Advances in the production of steam and the utilization of fuels are discussed. Information is presented in sections on the following: fundamentals of steam generation and use; steam generation from chemical energy; steam generation from nuclear energy; applications of steam; metallurgy and structural design; manufacturing and construction; and operation and maintenance. Tables of measurement and a glossary of symbols and abbreviations are included. (RCK)

15437 EJECTION VELOCITY AND RESIDUAL FILM DURING INITIAL EXPULSION OF SODIUM IN DIRECT-HEATED CHANNELS. Takahashi, K.; Fujii-e, Y.; Suita, T. (Osaka Univ., Suita, Japan). J. Nucl. Sci. Technol. (Tokyo); 10: No. 3, 176-185(Mar 1973).

An experimental study of transient boiling of sodium by direct heating is presented. Liquid sodium circulating by forced convection in a vertical tube of 14.9 mm inner diameter is heated by direct current (~4 V, ~5,000 A) applied through the sodium. The velocity of ejection of the vapor bubbles and the variations in the thickness of the film remaining on the channel wall were measured during a single bubble ejection. Furthermore, a simplified model formulated around the inertia of the liquid column was used to derive estimates for comparison with measured data. The experiments were performed within the following ranges: input power: 6 ~ 12 kW; pressure at the condenser: 0.6 ~ 1.1 kg/cm^2; flow rate: 1.0 ~ 3.5 l min; and inlet temperature: 750° ~ 850°C. The ejection velocity measured was between 2.0 and 16 m/s. The velocity increased with the degree of superheat, i.e., the velocity was governed by the degree of superheat in the region where the vapor phase expanded. The film thickness ranged from near zero to 1.0 mm. The film thickness increased with ejection velocity. (auth)

15438 TURBULENT HEAT TRANSFER IN A PIPE WITH ARBITRARY HEAT FLUX. 2. Aoki, S. (Tokyo Inst. of Tech.); Takahashi, T.; Shimazu, H. (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 116, 31-37(Mar 1973).

The turbulent heat transfer in a round pipe is one of the very important problems in engineering, especially for nuclear reactor engineering. Heat transfer with uniform heat flux and with constant wall temperature has been investigated by researchers for more than thirty years. Only few, experimental and theoretical researches on heat transfer with arbitrary heat flux however, have been reported. An experimental formula for heat transfer coefficients for sinusoidal heat flux distribution was obtained. The effect of heated section length on Nusselt number is also discussed and the empirical formula which has been obtained in the previous report is revised. (auth)

15439 HYDRAULIC FRICTION AND VELOCITY FIELDS IN TUBES HAVING ARTIFICIALLY-ROUGHENED WALLS. Millionshchikov, M. D.; Subbotin, V. I.; Ibragimov, M. Kh.; Taranov, G. S.; Kobzar, L. L. At. Energ. (USSR); 34: No. 4, 235-245(Apr 1973). (In Russian).

Experimental data on resistance coefficients and velocity fields in the range of Reynolds numbers from 4×10^3 to 1×10^6 are presented. Surface roughness consists of single-start threads of various profiles, multiple cross-triangular threads, circular grooves, pyramids, and semi-spherical ribs variously spaced. Hydrodynamic flow characteristics depend on the average height of roughness elements, dispersion of their heights, and on the form and spacing of these elements. The variety of roughened tubes available has made it possible to study the effect of each of the above factors on hydrodynamic flow, other geometry characteristics remaining unchanged. (auth)

15440 HEAT TRANSFER TO GAS–LIQUID MIXTURES IN A VERTICAL TUBE FITTED WITH TWISTED-TAPES. Nooruddin, A. F.; Murti, P. S. (Regional Research Lab., Hyderabad, India). Int. J. Heat Mass Transfer; 16: No. 8, 1655-1657(Aug 1973).

A brief outline is given of an experiment to study heat transfer under swirl flow conditions using twisted tapes of different sizes. Air and water were the two-phase fluids employed at 5 different flow rates of liquid, and superficial liquid Reynolds numbers from 4060 to 27500. Results are shown graphically for variations of heat transfer coefficient ratios plotted against gas to liquid volumetric flow rate ratios. The results are discussed and compared with those of other workers. (UK)

15441 TRANSIENT AND FORCED CONVECTIVE FILM BOILING IN SUBCOOLED WATER AT LOW REYNOLDS NUMBERS. Board, S. J.; Duffey, R. B. (Central Electricity Generating Board, Berkeley, Eng.). Int. J. Heat Mass Transfer; 16: No. 8, 1652-1655(Aug 1973).

Experiments are reported which were performed with small bodies at low Reynolds numbers to examine the heat fluxes and energy transfer processes relevant to the mixing and expansion stages of a thermal explosion. Data were obtained on both subcooled transient and forced convective film boiling from wires of Mo or W, immersed in distilled water. The results are analyzed. (UK)

15442 HEAT TRANSFER IN NUCLEATE BOILING. Maximum Heat Flux and Transition Boiling. Hesse, G. (Technische Univ., Berlin). Int. J. Heat Mass Transfer; 16: No. 8, 1611-1627(Aug 1973).

Characteristic boiling curves of the refrigerants Freon R12, R113, and R114 were determined for pressures up to 30 bar. The test fluids boiled on the outsides of a smooth nickel tube and of a grooved tube. By application of Stephan's stability condition, stable operating points could be maintained at maximum heat flux density and in the transition region. Due to the differing slopes of the characteristic boiling curves the stability condition in the transition region is easier to fulfill at low pressures than at high pressures. By using a test tube with grooves it was possible to favorably influence the shape of the characteristic boiling curves with respect to heat transfer and stability. (auth)

15443 MEASUREMENTS OF TRANSIENT HEAT FLUXES AND VAPOUR GENERATION RATES IN WATER. Duffey, R. B.; Clare, A. J.; Poole, D. H.; Board, S. J.; Hall, R. S. (Central Electricity Generating Board, Berkeley, Eng.). Int. J. Heat Mass Transfer; 16: No. 8, 1513-1525(Aug 1973).

Transient energy transfer processes under conditions of acoustic and high-pressure loading were examined experimentally by the rapid laser heating of metal foils under water. Heat fluxes and vapor layer thicknesses were deduced for the metal temperature range of 100 to 1000°C with water subcooling between 20 and 290°C. The data obtained permit a description of the energy transfer processes to be made for a wide range of conditions. (auth)

15444 TEMPERATURE AND EDDY DIFFUSIVITY PROFILES IN NaK. Sleicher, C. A.; Awad, A. S.; Notter, R. H. (Univ. of Washington, Seattle). Int. J. Heat Mass Transfer; 16: No. 8, 1565-1575(Aug 1973).

Local heat transfer coefficients and fully developed temperature profiles were measured in NaK eutectic mixture in a pipe at uniform wall temperature. Reynolds numbers ranged from 26,000 to 302,000 and flow was fully developed. Consistency of data was affirmed by three independent heat rate measurements. Eddy diffusivity profiles were used to calculate Nusselt numbers in pipes at uniform heat flux. Results for liquid metals are correlated by: $Nu(x) = Nu_\infty\ 1 + 2/(x/D),\ x/D > 4$; $Nu_{ave} = Nu_\infty\ 1 + 8/(L/D) + 2/(L/D)\ \ln\ (L/D)/4,\ L/D > 4$; where for uniform wall temperature $Nu_\infty = 4.8 + 0.0156\ Pe^{0.85}Pr^{0.93}$, $0.004 < Pr < 0.1$; and for uniform wall heat flux $Nu_\infty = 6.3 + 0.0167\ Pe^{0.85}Pr^{0.93}$, $0.004 < Pr < 0.1$. (auth)

Materials Testing

Refer also to abstracts 15413, 16044, 16049, 16128, 16131, and 17822.

15445 (EUR-5021) X-RAY CONTROL OF CORE PARTICLES FOR HIGH-TEMPERATURE REACTORS. Luchtmans, F. (Euro-

pean Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jun 1973. 41p. (In French). Dep. NTIS (U. S. Sales Only) $4.25. EUR FB 60,-.

The radiography of coated particles is relatively difficult due to dimensions, geometry, and changes in the absorption coefficients of the three layers around the core. The first problem solved was the display of the three layers, taking only one radiograph, allowing a very easy interpretation. In order to diminish the contrast of the fine-grain emulsion, a compromise was found between the high voltage, the emulsion type and treatment, the focus, and the exposure time. This compromise also permitted good radiographs of irradiated particles to be obtained. (auth)

15446 DESIGN OF A HIGH-RESOLUTION SYSTEM FOR NEUTRON RADIOGRAPHY. Rojas, M. J. Mexico City; Universidad Nacional Autonoma de Mexico (1973). 97p. (In Spanish). Thesis.

A high-resolution neutron radiography system in a beam tube of the TRIGA MARK III reactor of the Centro Nuclear de México is described. The system includes measurements of the thermal flux in different beam tubes in order to evaluate the adequacy of the system proposed. Measurements and maps were made of the thermal flux by the activation method and with a BF_3 proportional counter in the tube selected. The optimization of the collimator to be used and its construction are described. The optimization of the position of a neutron reflector within the same tube is also described. (JSR)

15447 ERROR SOURCES IN AUTORADIOGRAPHY. I. Kozma, L.; Bartha, L. (MTA Mueszaki Fizikai Kutato Intezet, Budapest). Izotoptechnika; 16: No. 5, 265-269(May 1973). (In Hungarian).

Topics discussed include the causes of artifacts, application of protective coatings to avoid chemical corrosion of the emulsion, methods for the distinction between the autoradiographic phenomena, and the blackening caused by the artifacts. (auth)

Nuclear Explosions

15448 (AWRE-Trans-65) FRENCH AND RUSSIAN PRESENTATIONS TO THE INTERNATIONAL ATOMIC ENERGY PANEL ON PEACEFUL NUCLEAR EXPLOSIONS. III. Applications, Characteristics, and Effects, Vienna, 27–30 November 1972. Mar 1973. Translated by F. E. Wallwork and W. E. Jones from report. (CONF-721143-). 149p. Dep. NTIS (U. S. Sales Only) $9.50. UK £2. 50 pence.

From panel on peaceful nuclear explosions, III: applications, characteristics and effects; Vienna, Austria (27 Nov 1972).

Abstracts were prepared for ten of the eleven papers presented. The remaining paper was previously abstracted for NSA. For an abstract of this paper see CONF-721108 in the Report Number Index. (TFD)

For abstracts of individual papers see: 15449–15458.

15449 (AWRE-Trans-65, pp 4-5) STATEMENT ON THE FRENCH PNE PROGRAMME. Sarcia, A. J. Mar 1973. Translated from report.

France's interest in the development of peaceful nuclear explosion technology is briefly discussed. Planned studies in this field include production of underground storage cavities for petroleum products, oil and gas well stimulation, mining, and civil engineering. (TFD)

15450 (AWRE-Trans-65, pp 6-18) FORECASTING OF RADIOACTIVITY LEVELS FOLLOWING A CONTAINED EXPLOSION. Dupuis, M.; Humbert-Dorz, C. Mar 1973. Translated from report.

The profitability of a project entailing the use of nuclear explosives may depend very much on the emission of radioactivity. In the case of a cavity for the storage of hydrocarbons, the permissible level of contamination can be determined on the basis of the subsequent uses of the products to be stored. In order to assess the profitability of a project, it is therefore necessary to make realistic forecasts of the levels of radioactivity that will exist in the cavity when it begins to be used and in the products subsequently withdrawn from it. The purpose of this paper is to show that such forecasts can be made. Once the quality and amount of radioactivity (fission products, tritium, activation) have been determined, the nature and level of the contamination of stored products can be assessed by studying the spatial and temporal evolution of the radionuclides (thermochemical study of the cavity and chimney). As far as the storage of hydrocarbons is concerned, particular emphasis is placed on the study of tritium. The results of this study are applied to the case of natural gas storage. (auth)

15451 (AWRE-Trans-65, pp 19-32) STUDY OF STORAGE CAVITIES PRODUCED BY NUCLEAR MEANS. Barthoux, A.; Faure, J.; Michaud, L.; Nelson, P.; Roux, C. Mar 1973. Translated from report.

The general conditions that make the underground storage of gas in France feasible are analyzed. The geological, geographical, and environmental criteria for selecting sites are reviewed. On the basis of the cost, seismic effects and, most important of all, the stability of the cavity, the authors arrive at a charge depth and energy compatible with the explosives envisaged. They then discuss the way in which such a cavity would be used, special attention being devoted to the evaluation of radioactivity hazards. (auth)

15452 (AWRE-Trans-65, pp 51-54) GEOPHYSICAL IMPORTANCE OF NUCLEAR EXPLOSIONS. Mechler, P. Mar 1973. Translated from report.

Nuclear explosions release sufficient energy to be detected a long way from the explosion site, so that measurements of interest to nearly all geophysicists, and impossible to effect by other methods, can be made. On the basis of underground explosions in particular, seismologists have already succeeded in drawing up more accurate tables of seismic wave propagation times than had existed previously. A series of measurements conducted with the aid of the French seismography service has also revealed asymmetries in the earth's crust that tend to confirm the new theory of crust layer tectonics. At the same time, the study of the amplitude of seismic waves, which is much too complex an undertaking when the waves are produced by earthquakes, has made substantial progress and led to a better understanding of the earth's structure. (auth)

15453 (AWRE-Trans-65, pp 55-68) DEVELOPMENT OF SCIENTIFIC-TECHNOLOGICAL BASES FOR CREATING UNDERGROUND STORAGE VAULTS IN A ROCK SALT MASSIF BY MEANS OF NUCLEAR EXPLOSIONS. Myasnikov, K. V.; Leonov, E. A.; Romadin, N. M. Mar 1973. Translated from report.

Scientific and technological recommendations on how to determine the main parameters of underground cavities created by nuclear explosions in rock salt formations are given. The necessary prerequisites and measures for obtaining air-tight underground storage spaces are discussed. Methods for estimating the stability of such cavities in the light of the depth of charge burial, the influence of the waves produced by the explosion, and the mechanical properties of the surrounding rock are given. (auth)

15454 (AWRE-Trans-65, pp 69-71) EFFECT ON BUILDINGS OF SEISMIC WAVES GENERATED BY UNDERGROUND NUCLEAR EXPLOSIONS. Kostyuchenko, V. N.; Rodionov, V. N.; Shamin, V. M. Mar 1973. Translated from report.

The damage to different types of buildings caused by seismic oscillations is classified. From experimental data on test and large commercial explosions oscillation velocity amplitude values which, if attained, cause different kinds of damage to buildings are derived. Taking into account the influence of the duration of oscillations in a seismic wave on the degree of damage to buildings, critical ground motion velocity amplitudes for the close-in and far-out zones are given. (auth)

15455 (AWRE-Trans-65, pp 72-87) SEISMIC WAVES GENERATED BY UNDERGROUND NUCLEAR EXPLOSIONS. Kostyuchenko, V. N.; Rodionov, V. N.; Sultanov, D. D. Mar 1973. Translated from report.

The groups of waves that have the strongest effect on residential and industrial buildings are discussed. The body waves produced by powerful underground explosions belong to this category. Empirical formulas are derived showing changes in the maximum amplitude of ground motion velocity in longitudinal waves as a function of distance within the close-in zone (up to 100 km). The relationship between the parameters of an emitter of elastic waves in the case of an underground explosion and the explosion energy and the strength characteristics of the rock at the point of detonation are considered. It is noted that, at distances greater than 100 km, the seismic effects of an explosion depend on the intensity of the body waves reflected from the Mohorovicic discontinuity. In conclusion, the possibilities of predicting the parameters of seismic waves produced by an explosion in a region which has not been subjected to thorough geophysical study are discussed. (auth)

15456 (AWRE-Trans-65, pp 88-101) USE OF LARGE EXPLOSIONS IN DAM CONSTRUCTION. Rodionov, V. N.; Romanov, A. N. Mar 1973. Translated from report.

The use of chemical explosions to construct earth dams on the Malaya Almaatinka and Vakhsh Rivers in the USSR is described.

The possibility of using nuclear explosions in the construction of such dams is discussed. (auth)

15457 (AWRE-Trans-65, pp 102-122) PHENOMENOLOGY OF ATMOSPHERIC AND GROUND CONTAMINATION BY PRODUCTS FROM UNDERGROUND NUCLEAR EXPLOSIONS. Izrael', Yu. A. Mar 1973. Translated from report.

On the basis of published experimental data, the atmospheric and local contamination resulting from underground nuclear explosions are described and classified in terms of the dose rate and dose, the concentration of radioactive products, the aerosol properties, and the isotopic composition, in the main contamination zones as a function of the conditions under which the explosions were conducted. (auth)

15458 (AWRE-Trans-65, pp 123-147) ACTIVATION OF ROCK AND THE FORMATION OF CARRIERS OF RADIOACTIVE PRODUCTS FROM UNDERGROUND NUCLEAR EXPLOSIONS. Izrael', Yu. A.; Ter-Saakov, A. E.; Vetrov, V. A.; Krasilov, G. A. Mar 1973. Translated from report.

The formation and distribution of radioactive materials from a cratering-type underground nuclear explosion are examined. (TFD)

15459 (FOA-4-4540-A-1) DEFINITION AND IDENTIFICATION OF SEISMIC EVENTS IN THE USSR IN 1971. Dahlman, O.; Israelson, H.; Austegard, A.; Hornstrom, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jun 1973. 49p. Dep. NTIS (U. S. Sales Only) $4.50.

Seismic events reported to have occurred in the USSR in 1971 were studied to assess the seismic monitoring problem as it may occur in the context of a complete test ban treaty. Epicenter data of 199 events, 180 earthquakes and 19 explosions, as given by the US National Oceanic and Atmospheric Administration, the Institute of Physics of the Earth, Moscow, and the Hagfors Observatory in Sweden are presented and compared. (auth)

15460 (UCID-16259) PROJECT RIO BLANCO: TECHNICAL STUDIES II. Toman, J.; Tewes, H. A. (California Univ., Livermore. Lawrence Livermore Lab). 26 Apr 1973. Contract W-7405-Eng-48. 149p. Dep. NTIS $9.50.

Project Rio Blanco is the first nuclear experiment utilizing the detonation of multiple explosives in a single wellbore to stimulate natural gas production. To support the formulation of a project definition document for this experiment, as well as to estimate the environmental consequences of the detonation, Lawrence Livermore Laboratory has continued to pursue technical studies in several pertinent areas. This document presents results obtained since the issuance of UCID-15968 (Jan. 24, 1972), and includes the elucidation of rock properties as determined with samples taken from the emplacement well (E. W.), a prediction of explosion effects (using the rock properties previously mentioned), an updated analysis of both the reservoir characteristics and the estimated gas production from the stimulated well, and a revised treatment of predicted gas quality. Add-on experimental programs are described and discussed. (auth)

Protective Structures and Equipment

15461 (CEA-N-1617) TESTS ON PRESSURIZED CLOTHING FOR WORK IN ENVIRONMENTS HIGHLY CONTAMINATED WITH TRITIUM. Le Bourdonnec, Y.; Colonna, P.; Renard, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1973. 9p. (In French). Dep. NTIS (U. S. Sales Only) $3.00.

Special pressurized clothing was developed to ensure the protection of personnel from an atmosphere contaminated by tritium or tritiated water. The special feature of this clothing resides in the use of a double envelope within which air circulates. The clothing was tested in a contaminated atmosphere. The tests performed simulated working conditions. An efficiency of 10^5 was obtained in relation to the contaminated environment. (FR)

15462 AEROSOL SAMPLING CONDITIONS IN EXHAUST SYSTEMS. Matsui, H. (Japan Atomic Energy Research Inst., Tokai); Yoshida, Y. Nippon Genshiryoku Gakkaishi; 15: No. 3, 165-173(Mar 1973). (In Japanese).

To estimate accurately the concentration of radioactive aerosols in an exhaust system, the following factors that lead to errors in aerosol sampling must be known: (1) the distance through the duct in which the aerosol mixes with air; (2) anisokinetic sampling; and (3) the fraction of aerosol deposited in the sampling pipe. Literature concerning the above problems is reviewed and the optimum sampling conditions are discussed. (auth)

Safety Engineering

15463 (LA-4037-SOP(Rev.)(Suppl. 1)) PAJARITO PLAN FOR RADIATION EMERGENCY. Paxton, H. C. (Los Alamos Scientific Lab., N. Mex). May 1973. Contract W-7405-eng-36. 4p. Dep. NTIS $4.00.

A plan for handling a radiation emergency that occurs during the handling of fissile material at a Kiva is presented. The plan sets forth the actions to be observed during an excursion in a Kiva with personnel present, accidental excursion during remote operation, and an emergency requiring site evacuation. (RCK)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstracts 15200, 15247, and 15490.

15464 (COO-3462-11) URANIUM GEOCHEMISTRY IN CARBONATES USING THE FISSION-TRACK METHOD. Technical Progress Report. Miller, D. S.; Friedman, G. M. (Rensselaer Polytechnic Inst., Troy, N. Y.). 1973. Contract AT(11-1)-3462. 10p. Dep. NTIS $3.00.

Progress is reported on studies of the geochemistry of uranium in carbonate sediments of different origins. Mg, Na, Ca, Sr, and K were determined for purposes of comparison with uranium. The concentration and distribution of uranium in carbonate sediments was determined, as well as the changes occurring during diagenesis. Two approaches were used to study changes occurring during diagenesis: (1) leaching and dissolution of carbonate sediments in the laboratory under various specified conditions and (2) analysis of carbonate sediments which had reached different stages in the diagenetic sequence. (auth)

15465 (PEL-212) SOME FAVOURABILITY CRITERIA IN THE SEARCH FOR URANIUM IN THE MAJOR SEDIMENTARY FORMATIONS OF SOUTH AFRICA. Von Backstroem, J. W. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Mar 1972. 30p. INIS.

The occurrence of uranium and criteria for locating new deposits in the major geological formations of South Africa are discussed. A short summary of the geology and mineralization of the Witwatersrand System for different localities within the basin, such as the Witwatersrand proper, the country between Randfontein and Potchefstroom, the Klerksdorp Area, and the Orange Free State, is given. The effects of nonconformities and disconformities, the nature of the mineralogy with regard to pay-streaks, stream channels, the floor of deposition, mineralogy, and possible sources of the uranium are reported on and discussed. Borehole results are analyzed with regard to uraniferous cycles, and the average content of uranium for certain zones and for the Witwatersrand System as a whole are given. The geology of the Transvaal and Ventersdorp Systems, including the Ventersdorp Contact Reef, are described, and the uraniferous nature of the conglomerates and of the Black Reef Series are indicated. Borehole results are illustrated by means of radiometric logs and the results obtained are analyzed. The heavy-mineral, fossil-beach deposits of the Bothaville Area, developed in the Middle-Ecca Stage of the Karroo System, are described and the general lack of uraniferous material in rocks of the Karroo System, in spite of a relatively high carbon content, is discussed. Mention is made of the Kalahari Formation and of results obtained by radiometric borehole logging as well as beach and river sands that contain radioactive minerals in certain areas. (INIS)

15466 (WASH-1242) NUCLEAR FUEL SUPPLY. (Division of Production and Materials Management (AEC), Washington, D. C.). May 1973. 11p. GPO $0.40.

The nuclear fuel supply is discussed in light of the important contribution that nuclear power is expected to make to production of electricity in the United States through the remainder of this century. Topics discussed are: nuclear power development; uranium requirements; uranium enrichment; U. S. uranium resources; production capability; desirable resource levels; supply and demand through 1990; higher cost resources; exploration; financial requirements; and foreign uranium supply. A list of selected AEC reports on nuclear fuel is included. (JGB)

15467 THORIUM CONTENT AND SPATIAL DISTRIBUTION IN MINERALS AND ROCKS AS DETERMINED BY TRACES OF FISSION FRAGMENTS. Berzina, I. G.; Gurvich, M. Yu. (All Union Scientific-Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR; 207: No. 6, 1441-1444(21 Dec 1972). (In Russian).

A method is described for ascertaining the distribution of Th and its concentration in minerals and rocks by making use of the (n,f) reaction and the resulting fission fragment track density. Required data include measurements of track density after irradiating rock specimen with and without a filter (Cd or B_4C), respectively. The sensitivity of the method for spatial distribution was $n \times 10^{-6}$ g/g. The chief limitation was the condition that the concentration ratio of Th and U, $C_{TH}: C_U \geq 0.5$. (KSW)

15468 URANIUM DISTRIBUTION IN CARBONATE SEDIMENTS OF A HYPERSALINE POOL, GULF OF ELAT, RED SEA. Amiel, A. J.; Miller, D. S.; Friedman, G. M. (Rensselaer Polytechnic Inst., Troy, NY). Israel J. Earth-Sci.; 21: 187-191 (1972). (COO-3462-9).

Blue-green algal mats carpet the "shelf" of a hypersaline pool of the coast of the Gulf of Elat. Fibrous aragonitic and cryptocrystalline high-magnesian calcite laminae are interlayered between the mats. The uranium concentration of the fibrous laminae is 3.5 ppM, whereas that of the cryptocrystalline laminae is 15 ppM. The increased concentration of uranium in the cryptocrystalline layers is related to the organic matter present in these layers and to their finer crystal size and hence greater specific surface area. In the non-organic matter the uranium occurs in exchangeable as well as in adsorbed sites from which the uranium can be readily removed by leaching with distilled water. (auth)

15469 PULSED NEUTRON LOGGING. Saha, H. K.; Narayanaswamy, A. K. (Petrol Explor Inst., Dehra Dun, India). Bull. Oil Natur. Gas Comm.; 8: No. 1, 1-10(1971).

A comprehensive review on pulsed neutron logging (neutron life time logging), basic physics of this modern tool, its limitation in commercial use, and its advantages over conventional neutron log are presented. (Indian Sci. Abstr.)

15470 ROCK LEAD ISOTOPES IN NORTHEAST QUEENSLAND. Black, L. P.; Richards, J. R. J. Geol. Soc. Aust.; 19: 321-330(Nov 1972).

U–Pb and Th–Pb studies of rocks from an extensive Paleozoic volcano-plutonic province in northeast Queensland support conclusions derived from a previous Rb–Sr study. The data oppose an earlier hypothesis, that two widespread and fundamentally different magma types are present. Interpretation of the lead data, however, must be treated with some caution since uranium movement apparently begins at a very early stage of weathering. X-ray fluorescence data are displayed in a manner which suggests a simple rejection criterion. (auth)

15471 LARGE AND IMPORTANT URANIUM DISCOVERY IN MINAS GERAIS. World Mining; 25: No. 3, 86(1972).

A large deposit of uranium that has not yet been evaluated has been discovered near the uranium mine of Campo de Agostinho. Its proximity to the mine of Campo de Agostinho and its very easy working will make it possible to decrease the cost of production per pound of uranium which is now $10 (U. S.). The deposit has been given the name C-Zero-9. (tr-auth)

15472 URANIUM RESOURCES AND PRODUCTION IN ISRAEL: FUTURE REQUIREMENT ESTIMATES. Com. Naz. Energ. Nucl., Notiz.; 19: No. 4, 56-60(Apr 1973). (In Italian).

A review of the uranium situation in Israel where, although no uranium ores have been found, uranium can be obtained from the large phosphate deposits in the Southern part of the country. The main phosphate deposits and the extraction methods used are described and some forecasts are made of future requirements in view of a possible construction of nuclear power plants. (auth)

15473 AUSTRALIAN URANIUM. Grenon, M. Rev. Fr. Energ.; 24: No. 249, 154-158(Jan 1973). (In French).

From electricity in the year 2000; Paris, France (7 Jun 1972).

The known uranium reserves of Australia represent at least 10% and possibly more nearly 25% of the reserves of the free world. The geographical distribution of these reserves is as follows: Northern territory (the Nabarlek, Ranger-I, and Jim Jim Creek deposits estimated to be between 100,000 and 150,000 tons of U_3O_8); Western Australia (Yeelirrie deposit having reserves estimated at 46,000 tons of U_3O_8); Queensland; and Southern Australia. The importance of the Japanese market and the policy of the Australian government, which tends to equilibrate the medium and long term sales, are discussed. Developing industrialization projects are considered (transformation of the oxide into UF_6; enrichment of the U; fuel assembly manufacture). An Australian electronuclear program is currently being studied. (FR)

15474 ISOTOPIC COMPOSITION OF CARBONATITE AND KIMBERLITE CARBONATES AND THEIR BEARING ON THE ISOTOPIC COMPOSITION OF DEEP-SEATED CARBON. Deines, P.; Gold, D. P. (Pennsylvania State Univ., University Park). Geochim. Cosmochim. Acta; 37: No. 7, 1709-1733(Jul 1973).

New carbon and oxygen isotopic compositions of carbonates from 14 carbonatite and 11 kimberlite occurrences are reported. A review of the available data on the carbon isotopic composition ranges of carbonatite and kimberlite carbonates shows that they are similar and overlap that of diamonds. The mean carbon isotopic composition of carbonates from 22 selected carbonatite

complexes (−5.1%, s = ±1.4% vs PDB) is indistinguishable from that of 13 kimberlite pipes (−4.7%, s = ±1.2%) as well as that of 60 individual diamond analyses (−5.8%, s = 1.8%). The oxygen isotopic compositions of kimberlite carbonates, however, are enriched in ^{18}O by several permil with respect to those of carbonates from the subvolcanic type of carbonatite. The data suggest that not all carbonatite, kimberlite and diamond occurrences have the same average carbon isotopic composition and that significant differences exist between them. Carbon isotopic composition measurements available for the East African Rift system suggest geographic and/or tectonic groupings, e.g., carbonate lavas, tuffs and intrusive carbonatites associated with the Eastern Rift yield a range of ^{13}C values from −5.8 to −7.4%, similar to that of the carbonate rocks associated with the Western Rift volcanism (−5.8 to −7.9%). In contrast the interrift area encompassing Lakes Victoria, Malawi (Nyasa) and Chilwa, apparently are characterized by carbonatitic carbonates of higher ^{13}C content (−2.4 to −4.4%). If carbonatite and kimberlite carbonates as well as diamonds represent deep seated carbon, the mean isotopic composition of this carbon is estimated as −5.2% and the range is −2 to −8%. The selection of any particular value within this range to be used as a criterion of deep-seated origin is at the moment not warranted. Indeed, the choice of any specific composition for such carbon may be meaningless, as the source of kimberlite, carbonatite and diamond carbon may not be isotopically uniform. (auth)

Radioactive Effluents

Refer also to abstracts 15486, 15512, 15712, and 17527.

15475 RADIATION DOSES IN THE ENVIRONMENT OF NUCLEAR PLANTS. Vogt, K. J. VDI (Ver. Deut. Ing.) Z.; 115: No. 6, 455-458(1973). (In German).

Standards of radiological protection of the environment, discharge of radioactive waste from nuclear plants, radiation doses in the environment of nuclear plants, and evaluation of environmental doses are discussed. (GE)

15476 SAFETY AND ENVIRONMENTAL PROTECTION PROBLEMS IN THE HANDLING OF RADIOACTIVE WASTES. Schwibach, J. (Bundesgesundheitsamt, Nuremberg). Atomwirt., Atomtech.; 18: No. 5, 231-234(1973). (In German).

Safety problems in the treatment of highly active waste solutions in reprocessing plants, the special situation in the USA with regard to the ultimate disposal of radioactive waste in the ground, the intermediate storage of solidified active residues in buildings, as well as the advanced and future concepts of the ultimate disposal of radioactive waste are considered. (GE)

15477 TO LIVE ON EARTH. Man And His Environment In Perspective. Brubaker, S. Resources For The Future Study. Baltimore; Johns Hopkins Press (1972). 216p. $6.95.

The environmental crisis is discussed under the following headings: man's accelerating use of the environment; environmental threats (including radioactivity); burdens on the receiving media; coping with environmental problems; some larger considerations; and summary and prospect. (ERB)

Radioactivity Monitoring and Transport

Refer also to abstracts 15817 and 15818.

15478 (BMI-X-649) ECOLOGICAL AND ENVIRONMENTAL THESAURUS. Mayer, R. A.; Jefferis, J. A.; Eischen, M. A.; McBride, J. L.; Davidson, R. S. (comps.). (Battelle Columbus Labs., Ohio). 30 Jun 1973. Contract W-7405-eng-92. 935p. Dep. NTIS $48.75.

A preliminary draft is presented of the Ecological and Environmental Thesaurus prepared by Battelle's Columbus Laboratories to provide an organized core of terminology which describes the scope of work of the U. S. Atomic Energy Commission, Division of Biomedical and Environmental Research, whose mission is to assure that nuclear activities are conducted with due regard to human health and safety and to the protection of the environment. It incorporates terms related to: sources of environmental impacts and health hazards; environmental impacts; public health and welfare; land use impacts; aesthetics; and antiquities and archeology. It interrelates concepts associated with biological, ecological, technological, socio-economic, meteorological, geological, and chemical and physical considerations. While the primary function of the thesaurus is to identify the contents of scientific and technical works by the use of keywords, this collection may also be used as a basis for outlining a problem. It might serve as a guide to define specific ecosystems, as an outline for collecting data for the preparation of environmental assessments, in baseline studies for large areas, in determining socioeconomic-aesthetic impacts, and in studying energy problems. It is not limited to nuclear problems but considers the total environment and the effects on it of alternative energy sources. In scope, the thesaurus reflects the ecological and environmental interests of the U. S. Atomic Energy Commission, the U. S. Environmental Protection Agency, the U. S. Department of the Interior, other governmental agencies, and industry. It is designed for local, regional, national, and international application. The index may be used in both manual and mechanized retrieval systems. (auth)

15479 PROCEEDINGS OF THE COLLOQUIUM ON CONSERVATION PROBLEMS IN ANTARCTICA, BLACKSBURG, VIRGINIA, SEPTEMBER 10–12, 1971. Parker, B. C. (ed.). Blacksburg, VA; Virginia Polytechnic Institute and State University (1972). 363p. (CONF-710984-).

The need for the conservation of aquatic and terrestrial ecosystems of Antarctica and measures used for the protection of the environment from pollution are discussed in 23 papers. A separate abstract was prepared for one paper that discussed the radioactive contamination of the environment. (CH)

For an abstract of an individual paper see: 15482.

Atmosphere

Refer also to abstracts 15508, 15710, and 15803.

15480 (ARMS-73.6.1) AERIAL RADIOLOGICAL MEASURING SURVEY OF THE AREA SURROUNDING THE SHIPPINGPORT ATOMIC POWER STATION, SHIPPINGPORT, PENNSYLVANIA, FEBRUARY 1973. (EG&G, Inc., Las Vegas, Nev). Jul 1973. 15p. Dep. NTIS $4.00.

The Aerial Radiological Measuring System (ARMS) was used to survey the Shippingport Atomic Power Station and surrounding area on February 24, 1973. The survey measured terrestrial background gamma radiation. A high-sensitivity detection system collected gamma spectral and gross-count data. The data were then computer processed into a map of a 530 square mile area showing isoexposure contours three feet above the ground. Results indicated the presence of isotopes normally found in the background radiation throughout the United States. (auth)

15481 (COO-3425-7) MEASUREMENT OF AIRBORNE RADIOACTIVITY AND ITS METEOROLOGICAL APPLICATION. Part III. Annual Report, April 1, 1971–March 31, 1972. Reiter, R.; Sladkovic, R.; Poetzl, K.; Kanter H. J. (Fraunhofer-Gesellschaft, Garmisch Partenkirchen (West Germany). Physikalisch Bioklimatische Forschungsstelle). Feb 1973. Contract AT(11-1)-3425. 172p. Dep. NTIS $10.75.

Initial definite results obtained by a previously described method of studying the exchange of air masses between stratosphere and troposphere are presented. The physical measuring techniques were considerably improved and the radionuclides ^{7}Be, ^{32}P, ^{33}P, ^{35}S, and the fallout heavy metals are now measured with adequate accuracy. A continuous meteorological analysis was made for a period of 49 days. By comparing the condition of the atmosphere during intervals with an influx of stratospheric air to a fixed point on the earth's surface against the condition of the atmosphere during intervals without such influx, a number of indicators were developed which both characterize stratospheric-tropospheric exchange well, and contain a forecasting potential. (105 references) (auth)

15482 RADIOACTIVE CONTAMINATION IN THE ANTARCTIC. Hedgpeth, J. W. (Marine Science Center, Newport, OR). pp 97-112 of Proceedings of the Colloquium on Conservation Problems in Antarctica. Parker, B. C. (ed.). Blacksburg, Va.; Virginia Polytechnic Institute and State University (1972).

From conference on conservation problems in Antarctica; Blacksburg, Virginia, USA (10 Sep 1971). See CONF-710984-.

The principal sources of radioactivity in environmental samples of Antarctica are fallout from atmospheric nuclear weapons tests and radioisotopes used as tracers in biological, chemical, and geological studies. The barrier of free air circulation between northern and southern hemispheres at the lower levels of the troposphere has been demonstrated by the transport time and pattern of fallout radioisotopes. The ^{90}Sr in fallout from the Castle nuclear test series in 1955 marked the Antarctic snow and ice and can still be easily detected, and uneven distribution of small amounts of ^{14}C some other radioisotopes from atmospheric tests have also been observed. The use of radio-

isotopes as tracers in Antarctica has been carefully documented since 1967 and monitoring programs have proved effective in accounting for the source of all radioactivity. (CH)

Soil

15483 (ORO-4394-1) WIND EFFECTED REDISTRIBUTION OF SURFACE CONTAMINATION. Progress Report, September 1972–August 1973. Amato, A. J. (Norfolk State Coll., Va. (USA)). 1973. Contract AT(40-1)-4394. 5p. Dep. NTIS $3.00.

A mathematical model was developed for use for computer calculations of the redistribution of surface soil contaminants as a function of down wind distribution and erosion or weathering variables. A computer program, SDIST, was developed for plotting the concentrations as a function of time for each space interval and steady state isopleths. (CH)

15484 (RISO-278) PLANT ACCUMULATION OF RADIOACTIVE STRONTIUM WITH SPECIAL REFERENCE TO THE STRONTIUM–CALCIUM RELATIONSHIP AS INFLUENCED BY NITROGEN. Andersen, A. J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1973. 53p. Dep. NTIS (U. S. Sales Only) $4.75.

Investigations are reported on strontium accumulation in plants grown in soils which were artificially contaminated with water-soluble radioactive strontium. Since the strontium-90 in radioactive fallout has been shown to be largely water-soluble, the results from such experiments are assumed to be closely related to the conditions encountered in actual fallout situations. The purpose of these investigations was to elucidate the consequences of a heavy contamination of agricultural areas with radioactive strontium and to evaluate the possibilities of influencing the amounts accumulating in crop plants. The plant uptake of strontium is closely related to that of calcium and depends on the relative concentrations of the two cations adjacent to the root surface. Soil properties, which affect the relative availability of strontium and calcium, were evaluated for some typical Danish soils. The uptake of strontium can be influenced either by changing its actual concentration in the soil solution adjacent to plant roots or by changing the competition from calcium. Both possibilities were tested. An effective reduction in strontium uptake was obtained by heating the contaminated soil layer and by deep ploughing. The availability was also effectively reduced by heavy applications of superphosphate, whereas application of lime proved to be rather ineffective to reduce the uptake from most of the soils used. The uptakes by different plant species and varieties were compared in pot experiments and the results revealed considerable variation in the strontium uptake by barley, oats, and rye grass. It was shown in pot experiments that nitrogen supply changed the relative distribution of strontium and calcium in oat plants. Since nitrogen is one of the most important growth factors in modern agriculture this was considered of great practical interest and it was therefore decided to elucidate these effects in more details. Attempts were made to evaluate how nitrogen addition affects the sequence of reactions which determines the strontium–calcium movement from the soil solid phase to the grain of oat plants. The main results have been published and the references are given. (CH)

15485 (RLO-2225-T-18-4) STUDIES OF CONCENTRATIONS OF UNREPORTED LONG-LIVED RADIONUCLIDES IN BIOTA AND OCEAN SEDIMENTS AT BIKINI AND ENIWETOK ATOLLS. Annual Progress Report, 1972–1973. Schell, W. R. (Washington Univ., Seattle. Lab. of Radiation Ecology). 1 May 1973. Contract AT(45-1)-2225. 19p. Dep. NTIS $3.00.

Data are presented on the content of ^{241}Am in samples of seawater and sediments from various depths collected at Bikini Atoll in 1972. The total α activity in sediments was also measured. Separation procedures used in the preparation of the samples for radiometric analysis are described. Methods for use in the determination of Pu, Np, and Am in biological materials were also investigated. (CH)

Water

15486 (BNWL-SA-4614) SOURCES AND INVENTORY OF RADIOACTIVITY IN THE AQUATIC ENVIRONMENT. Foster, R. F. (Battelle Pacific Northwest Labs., Richland, Wash). Jun 1973. Contract AT(45-1)-1830. 26p. (CONF-730603-7). Dep. NTIS $3.50.

From 18th Health Physics Society meeting; Miami Beach, Florida, USA (17 Jun 1973).

Data are summarized on the sources and radioactivity of radionuclides in surface waters of the world during 1970 through 1972. The inventory of natural radionuclides (tritium, ^{14}C, ^{7}Be, ^{40}K, ^{87}Rb, ^{238}U, ^{235}U, ^{226}Ra, and ^{232}Th and daughter products) is discussed. Man-made radionuclides constitute about 0.2% of the inventory in the oceans. Virtually all of this activity is from tritium released as fallout during the testing of nuclear devices in the atmosphere. Fallout ^{14}C amounts to about 5 megacuries compared to the 250 megacuries present naturally. Data are presented on the content of ^{54}Mn, ^{58}Co, ^{60}Co, ^{89}Sr, ^{90}Sr, ^{131}I, ^{91}Y, ^{140}Ba, ^{144}Ce, ^{55}Fe, ^{54}Mn, ^{134}Cs, and ^{137}Co in liquid wastes from the Dresden-I BWR and Indian Point-I PWR power reactor; the inventory of ^{54}Mn, ^{46}Sc, ^{32}P, ^{60}Co, ^{65}Zn, ^{51}Cr, ^{131}I, ^{95}Zr, ^{95}Nb, ^{122}Sb, ^{106}Ru, ^{99}Tc, and tritium from Hanford reactor wastes in the Columbia River and Northeast Pacific Ocean during 1970; the release of tritium to the Savannah River from operations of the Savannah River Plant; the release of ^{106}Ru, ^{90}Sr, and ^{137}Co to the Clinch River during 20 years of operating of the Oak Ridge National Laboratory; the release of ^{106}Ru to the Rhone River in wastes from the fuel element reprocessing plant at Marcoule, France; and the release of tritium from the fuel reprocessing plant at Windscale, Great Britain. The nuclear power industry contributes less than one megacurie to the activity present in the oceans. Other sources of radioactive materials in surface waters include: the marine disposal of packaged low-level radioactive wastes; the discharge of radioactive wastes from nuclear powered surface ships and submarines; nuclear auxilliary power systems (SNAP devices); and radioisotopes introduced into the aquatic environment for use as tracers to study physical, chemical, or biological processes, also included on the inventory of fallout ^{137}Co and ^{90}Sr in the oceans and in Lake Michigan. (CH)

15487 (UCSD-10-P-20-152) RESEARCH ON THE MARINE FOOD CHAIN. Progress Report, July 1972–June 1973. Part I. Introduction and Account of Work in Progress. Part II. Manuscript Reports of Work Concluded. Part III. Data Record. (California Univ., La Jolla. Inst. of Marine Resources). 1973. Contract AT(11-1)-Gen-10. 711p. Dep. NTIS $37.75.

Results are summarized from studies on nutrient cycling in the marine pelagic food chain. Emphasis was placed on the influence of the chemical and physical environment of the Pacific Ocean on photosynthetic activity of marine plants and the cycling of C and N through algae, plankton, crustaceans, and other invertebrates. Papers submitted for publication during the period covered by the report are included. One paper reports the results of measurements of fallout tritium in seawater samples collected in the Antarctic Ocean during 1972. (CH)

Ecosystems and Food Cycles

Refer also to abstracts 15494, 17759, 17786, and 17798.

15488 (RT-PROT-(72)44) RADIOACTIVE CONTAMINATION AND CLASSIFICATION OF GROUND-WATER. Cigna, A. A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [nd]. 5p. (In Italian). (CONF-701236-1). Dep. NTIS (U. S. Sales Only) $3.00.

Because of the importance of groundwater in the water supply of the population, due to the high level reached by the conventional contamination of surface water, study of the radiocontamination of groundwater has become undelayable. At the same time a proper definition of standards for groundwater will provide the best utilization of resources. The different sources of radiocontamination are considered. The physical and chemical characteristics of soils influencing the distribution patterns of the radiocontaminants are described. The characteristics of aquifers are also examined with reference to their potential for radiocontamination. The criteria for water classification of groundwater according to the different uses are considered. The opportunity to change the criteria actually followed is emphasized in order to take into consideration the concentration phenomena observed in many biological processes. (auth)

15489 CONSEQUENCES OF AN ACCIDENTAL RELEASE OF SODIUM TO THE ENVIRONMENT FROM AN LMFBR. Tadmor, J. (Israel Atomic Energy Commission, Yavne). Nucl. Safety; 14: No. 4, 324-340(1973).

A theoretical evaluation has been made of the consequences of an environmental release of sodium in the form of an airborne cloud resulting from a sodium fire in a liquid-metal-cooled fast breeder reactor. The evaluation takes into consideration only the hazards of the radioisotopes of the sodium. Problems associated with accompanying fission products were not included. On the basis of conservative assumptions, the data show that the most significant exposure would be to a child through the forage–cow–milk food-chain pathway. The whole-body dose for an instantaneous direct environmental release of 1 g of sodium (containing 0.31 Ci of ^{24}Na and 1.8×10^{-4} Ci of ^{22}Na)

would be about 0.2 rem; the corresponding dose resulting from a release of 1000 g of sodium within the reactor containment vessel, followed by a subsequent containment-vessel leakage rate of 0.1%/day, would be about 13 rems. Restrictions on the use of milk and milk products would considerably reduce these values. Other possible countermeasures that might be taken to cope with the environmental hazards are also discussed. (auth)

Radiometric Techniques

Refer also to abstracts 15470 and 16885.

15490 SPACE-AGE NEUTRON DISTRIBUTIONS OF URANIUM NUCLEI UNDERGOING SPONTANEOUS FISSION IN TWO-LAYER MEDIA HAVING CYLINDRICAL BOUNDARIES. Davydov, Yu. B. At. Energ. (USSR); 34: No. 4, 271-275(Apr 1973). (In Russian).

The neutron distribution of uranium nuclei undergoing spontaneous fission is considered for the case of a borehole. To solve this problem the age approximation of neutron transport theory is used. The results of numerical calculation of spectral neutron flux can be used in geophysical practice in the interpretation of neutron well logging curves. (auth)

15491 TREE-RING CALIBRATION OF RADIOCARBON DATES AND THE CHRONOLOGY OF ANCIENT EGYPT. Clark, R. M. (Sheffield Univ., Eng.); Renfrew, C. Nature (London); 243: No. 5405, 266-270(1 Jun 1973).

The historical calendar of Ancient Egypt is the only independent chronology for testing the bristlecone pine calibration of the radiocarbon time scale from 3000 to 1800 BC. Here a statistical approach is used to compare the functions relating the Egyptian historical dates to the corresponding radiocarbon dates and the bristlecone pine tree-ring dates to the corresponding radiocarbon dates, and it is concluded that the calibrated radiocarbon dates for Egypt do not differ significantly from the historical dates in the time period considered, although the errors associated with these preclude a precise comparison. The accord gives qualified support for both systems and invalidates some published objections to the use of a calibrated time scale in prehistoric archaeology. (auth)

Site Surveys

15492 (BNWL-SA-4722) TOMORROW'S ENVIRONMENTAL BENEFIT/COST ANALYSIS. Burnham, J. B. (Batelle Pacific Northwest Labs., Richland, Wash). 17 May 1973. 18p. Dep. NTIS $3.00.

Criteria are presented for use in the evaluation of the impact of a nuclear power plant on the environment. Criteria are included for evaluation of the aesthetic impact, land use, economic aspects, water impact, air impact, cultural impact, ecological impact, and impact on public health and safety. It is emphasized that acceptable criteria should be premised on the attendant benefits to be expected. (CH)

15493 (DOCKET-700364-1) NUMEC TYPE II FACILITY. Certificate Granted by Pennsylvania Department of Environmental Resources. (Nuclear Materials and Equipment Corp., Apollo, PA). 3 May 1973. 5p. Dep. NTIS $3.00.

15494 (ORNL-TM-3619) ECOLOGICAL-ENVIRONMENTAL ASSESSMENTS RELATED TO THE FEDERAL REPOSITORY. Dahlman, R. C.; Tanaka, Y. (Oak Ridge National Lab., Tenn). Jul 1973. Contract W-7405-eng-26. 53p. Dep. NTIS $4.75.

In ecological assessments related to the proposed federal repository for radioactive wastes at Lyons, Kansas, those environmental pathways expected to be important in radionuclide movements were identified from on-site surveys by consultants from Kansas State University. Based on systems analysis techniques and existing literature information on radionuclide behavior in ecosystems, the dynamics of ^{90}Sr was estimated for plant, litter, and soil pathways of a generalized grassland ecosystem. Continuous, low-level release of ^{90}Sr from repository operations would lead to three-fold increases in the concentration in litter according to this simulation. Subsequent redistribution or concentration through animal food chains are topics for further study. Preliminary assessment also has focused on energy balance in the biotic environment. Based on preliminary calculations, heat flux from waste deposits probably will be several orders of magnitude less than the daily bidirectional solar-induced flux at the soil surface, and surface temperature increases from waste heating will be small or negligible. Additional on-site confirmational studies are planned on this subject. Preliminary information has been assembled on urban and rural population trends in Rice County, on agricultural activities in the vicinity of Lyons, on projected ecological characteristics of a reconstituted grassland ecosystem, and on meteorological parameters which will affect the local environment and which may influence repository operations. Plans for future research call for intensive investigation of principal affected ecosystems (grassland pasture, wheat agroecosystem, Cow Creek) to collect the required technical information for assessing the conceivable impact of chronic or accidental contamination on biotic populations and ecosystems. (auth)

15495 (USGS-474-171) WATER LEVELS AND SPRING DISCHARGES FOR SELECTED WELLS AND SPRINGS IN NEVADA, 1966-69. Gonzalez, D. D.; Warren, C. T.; Washington, C. L. (Geological Survey, Lakewood, Colo.(USA)). Jul 1973. Contract AT(29-2)-474. 69p. Dep. NTIS $5.45.

Surface-water and ground-water data are collected from selected wells and springs in Nevada. Data presented are for the period 1966-69 and were collected from ground-water wells, gaging stations, miscellaneous sites, and four hot spring sites. A brief description of location of measurement sites is given. The data collection network is to evaluate possible effects of nuclear explosions on the hydrology of springs and wells. (auth)

Thermal Effluents

Refer also to abstracts 15478 and 17422.

15496 (HEDL-TME-73-17) THERMAL EFFECTS OF PROJECTED POWER GROWTH: PACIFIC RIVER BASINS. Peterson, D. E.; Schrotke, P. M.; Engstrom, S. L.; Bailey, G. F. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1973. Contract AT(45-1)-2170. 112p. Dep. NTIS $7.75.

Direct cooling capacities of eight major Pacific Slope river systems (excluding the Columbia-Snake) were calculated for average and low flow conditions. Total regional capacity, considering not only direct heating of the rivers, but also their ability to dissipate heat to the atmosphere, ranges from a high of 33 GW_T to a low of 14 GW_T. The Colorado River contributes essentially all of the capacity in the region. Of the remaining rivers (Skagit, Chehalis, Umpqua, Roque, Klamath, Eel and Sacramento), only the Skagit has a potential to assimilate 800 MW_T or more under low flow conditions (90% of the time or more on a monthly basis) and restrictions imposed by state Water Temperature Standards. Considering that, on the average in the region, approximately 1.55 MW_T are rejected to cooling water for each MW_e generated (corresponding to a fossil fuel plant efficiency of roughly 34%), the available cooling capacity will support ~9 GW_e at one time. Although improvements in plant efficiency could increase this somewhat, analysis of projected power generation patterns indicates that this is insufficient to cool (on a once-through basis) the anticipated growth in the electrical generation industry, and that recourse to supplemental cooling techniques will be required throughout the Pacific Region. (auth)

15497 (K-TRANS-67) FOG AND SLEET FORMATION IN COOLING TOWER OPERATION. Bach, H. Translated from Tech. Mitt.; 65: No. 5, 230-236(1972). 19p. Dep. NTIS $3.00.

The need for removing reject heat from production processes by cooling towers is considered. This increases the amount of water vapor and of unavoidably entrained water drops discharged into the atmosphere. Although the fog frequency is not significantly increased by these phenomena, the number of days of sleet do increase in a zone up to a maximum distance from the cooling tower depending on the drop radius, relative humidity, and the falling height. Additional fog formation is attributable to recondensing water vapor in cold ambient air and thus to evaporation losses. It occurs particularly during inversions and can be controlled more easily with high than with low cooling towers because the former are more likely to project above descending inversions and for a longer time above forming ground inversions. Precipitation around a cooling tower can be significantly reduced by drop collecting devices, which should be further improved if possible. Since the air in natural draft cooling towers as a rule is discharged at a lower velocity than from cooling towers with blowers, and because the entrained drops reach their stationary falling velocity sooner, the amounts of precipitation in the maximum zone can be notably reduced. This admittedly is realized at the expense of an increase of the loaded area around the cooling tower, so that the zone in which sleet may form on frozen ground is also slightly enlarged. But since the distance in which any precipitation can occur at all is limited by the rapid evaporation of the small water drops with the greatest

range, a limit exists for sleet formation, which also cannot be exceeded by the discharge of entrained drops from cooling towers operating with a very large volume of water in the cycle. (auth)

15498 ECOLOGICAL COMPARISONS OF THERMALLY AFFECTED AQUATIC ENVIRONMENTS. Parker, E. D.; Hirshfield, M. F.; Gibbons, J. W. (Savannah River Ecology Lab., Aiken, SC). J. Water Pollut. Contr. Fed.; 45: No. 4, 726-733 (Apr 1973).

Species composition and relative abundance of certain organisms were compared in three reservoirs differently affected by thermal effluents from Savannah River nuclear reactors. Biological and physical characteristics of three ponds, Par Pond, Pond B, and Pond C, are described. The greatest number of species of vascular aquatic plants, fishes, and reptiles was found in Par Pond; the number of species was much lower in Pond B, and still lower in Pond C. The most obvious environmental feature to which these differences can be related is the thermal regime. Relative abundance of most plant species was reduced in the portion of a reservoir receiving chronic thermal loading. Relative abundance of certain plant species was consequently enhanced, possibly a result of reduced competition from other species. (HLW)

15499 ESTIMATION OF PLUME RISE FOR LARGE THERMAL SOURCES. Deland, R. J. (New York Univ., NY). J. Air Pollut. Contr. Ass.; 23: No. 4, 293(Apr 1973).

Estimates were made of plume rise from fossil-fueled power plants using two different formulas. Results obtained are compared. (CH)

15500 RELATION BETWEEN UTILIZATION OF WATERS FOR COOLING PURPOSES AND WATER QUALITY. Gerking, E. (Preussische Elektrizitaets AG, Hanover). (1973). vp. (In German).

From VGB conference: power plant and environment, 1973; Essen, Germany (27 Feb 1973).

Up to now, results of practical investigations did not show any serious deterioration of the water quality due to river water cooling. The inconsistency between the apprehensions voiced by various groups and reality could be demonstrated by a thorough, comprehensive investigation of biological as well as physical factors and effects. The given upper temperature limits, along with an efficient oxygen enrichment of the water (done within the power plant itself), allow for a considerable utilization of surface waters for power plant cooling. It can even be said that an appropriate site planning will contribute to improving the water quality.

Chemical Effluents

Refer also to abstracts 15478 and 17734.

15501 (ANL/ES-23) CHLORINATION EXPERIMENTS AT THE JOHN E. AMOS PLANT OF THE APPALACHIAN POWER COMPANY: APRIL 9-10, 1973. Draley, J. E. (Argonne National Lab., Ill.). Jun 1973. Contract W-31-109-eng-38. 26p. Dep. NTIS $4.00.

In two special runs, free and total residual chlorine were measured in the circulating-water system of the cooling tower for the Amos Plant Unit 1. For a typical chlorination period, in which the concentration of free chlorine at the condenser was about 0.1 ppM, the total residual-chlorine concentration reached maxima of 0.63 ppM at the condenser discharge and 0.32 ppM in the discharge from the cooling-tower basin. These residual chlorine levels declined after the addition of chlorine was stopped, but more than 2 hr elapsed before the residual chlorine could no longer be detected by the amperometric-titration method (sensitivity perhaps 0.01 or 0.02 ppM). The data for the buildup of residual chlorine at the condenser were fitted with a kinetic expression in which some reduction of chlorine to chloride and some formation of chloramines are assumed. Good fits, with reasonable values of the constants, suggest that the model is correct. The data for gradual decay of combined chlorine were fitted with an equation based on a model in which the chlorine is assumed to be lost in the blowdown and by processes within the system. Again, good fits, with reasonable parameters, gave credence to the model. The calculated fraction of the chloramines lost per pass through the circulating-water system was 0.4. (auth)

15502 (LA-UR-73-642) DISTRIBUTIONS AND ASSOCIATIONS OF SOME OF THE CHEMICAL ELEMENTS FOUND IN THE STRATOSPHERE. Sedlacek, W. A.; Guthals, P. R. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract AT(29-2)-3139. 4p. (CONF-730625-1). Dep. NTIS $3.00.

From conference on environmental impact of aerospace operations in the high atmosphere; Denver, Colorado, USA (11 Jun 1973).

Aerosols present in the lower stratosphere were collected on I.P.C. filters using USAF WB-57F aircraft. The samples were examined by neutron activation analysis, scanning electron microscopy, and chemical analysis of water-soluble material. Studies of the collection mechanisms of the samplers and analysis of samples collected during a Sept. 1972 Lidar-Balloon-Aircraft cross-calibration experiment suggest the association of sulfate, sodium, magnesium, and chlorine with particles larger than 0.2 micrometers, and nitrate and calcium with vapors or Aitken nuclei. In addition, latitudinal iodine concentration variations were measured from 75°N to 51°S on the AEC Project Airstream sampling missions in Oct. of 1972. Although the results from one set of samples can not show what effect is contributed by seasonal variations, a curious higher concentration of iodine in the Northern mid-latitudes existed during Oct. 1972. A set of samples collected in May of 1973 should show the effect of seasonal variations. Examination of tropical upwellings and thunderstorms that penetrated the tropopause gave low iodine concentrations indicating that they are probably not principal injection mechanisms. The remaining question is whether vertical diffusion and mixing across the tropopause are represented by these iodine concentrations. (auth)

15503 (LA-UR-73-678) BERYLLIUM, THE CRITERIA DOCUMENT. Schulte, H. F. (Los Alamos Scientific Lab., N. Mex). 1973. Contract W-7405-eng-36. 13p. (CONF-730518-4). Dep. NTIS $3.00.

From AIHA conference; Boston, Massachusetts, USA (20 May 1973).

Beryllium is an especially toxic substance used industrially. Standards for Be air concentrations, ventilation, personnel protection by the use of face masks, and waste disposal adopted by the USAEC in 1949 are reviewed and compared with standards proposed recently under the Occupational Safety and Health Act. (CH)

15504 (ORNL-NSF-EP-56) DEVELOPMENT OF AIR QUALITY INDICES. Summary Report. Shults, W. D.; Beauchamp, J. J. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 69p. Dep. NTIS $5.50.

Several indexing schemes are described that were developed for meaningful communication about air quality. Rationales, characteristics, evaluative data, and FORTRAN computer codes used with each of the indexing concepts are included. (CH)

15505 (ORNL-tr-2548) MAINTAINING CLEAN AIR IN NONFERROUS METAL OPERATIONS. Part II. Particulate and Gaseous Emissions of the Nonferrous Metal Industry and the Limiting of Emissions. Knop, W. Translated by R. G. Mansfield from Metall.; 22: No. 12, 1266-1271(1968). 23p. Dep. NTIS $3.25.

Sources of air pollutants in metallurgical plants that process nonferrous metal ores and concentrates or remelt scrap are reviewed. Health hazards to personnel from the inhalation or ingestion of toxic substances are discussed. Emphasis is placed on hazards from sulfur oxides, hydrochloric acid, ammonia, fluorine, arsenic, beryllium, lead, and metal dusts. (CH)

15506 (PTB-Ra-3) PARTICULATE SULPHUR CONCENTRATION IN GROUND LEVEL AIR IN NORTH GERMANY AND NORTH NORWAY. Kolb, W. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). May 1973. 14p. Dep. NTIS (U. S. Sales Only) $3.00.

Samples of surface air collected in Germany and Norway were analyzed for sulfur particulate concentrations. The sulfur concentration in air in North Norway was considerably lower than in air samples from an industrial area in Germany. Possible explanations for seasonal variations observed are discussed. (CH)

15507 (RLO-2225-T-24-5) SORPTION-DESORPTION REACTIONS OF MERCURY WITH SUSPENDED MATTER IN THE COLUMBIA RIVER. Bothner, M. F.; Carpenter, R. (Washington Univ., Seattle. Dept. of Oceanography). 1972. 15p. Dep. NTIS $3.00. (SM-15815).

The influence of Columbia River suspended matter on the fate of dissolved mercury in the river and during the transition from the river to the oceanic environment was investigated. The approach was to spike natural Columbia River water with ^{203}Hg-labeled mercuric nitrate and methyl mercury chloride under laboratory conditions and to follow the reactions of the radioactive species with the suspended matter during exposure to river water and to seawater. The concentrations of natural mercury in Columbia River water, its suspended matter, and

bottom sediments were also determined. The partitioning of both natural and radioactive mercury species between the dissolved and suspended phases was very similar. Between 50 and 75% of the natural mercury and the added radioactive species was associated with the particulates. Both inorganic and methyl mercury are fairly rapidly taken up by the natural assemblage of Columbia River particulates. The desorption experiments show that at least half of each of these forms is fairly easily desorbed by filtered river water of lower total mercury content. Subsequent washes with seawater remove little additional mercury from the particulates during roughly one week contact time. (auth)

15508 (UCRL-51405) AQUATIC AND ATMOSPHERIC SIMULATION. Knox, J. B.; Hardy, D. M.; Sherman, C. A. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Jun 1973. Contract W-7405-eng-48. 13p. Dep. NTIS $4.00.

The development of numerical simulation models of atmospheric and aquatic pollution transport, transformation, and deposition is discussed. Applications of the models in tracing air pollutants from the source to receptor are described in which a code, ADPIC, was used for computer calculations of three-dimensional particle diffusion. Other proposed applications in studies of environmental pollution include water pollution problems, waste discharge, water quality studies, sediment transport, integrated aquatic intake studies, and studies of time integrated pollution exposures in the atmosphere. (CH)

15509 SIMPLIFIED TECHNIQUE USED TO EVALUATE ATMOSPHERIC DISPERSION OF EMISSIONS FROM LARGE POWER PLANTS. Montgomery, T. L.; Norris, W. B.; Thomas, F. W.; Carpenter, S. B. (Tennessee Valley Authority, Muscle Shoals, AL). J. Air Pollut. Contr. Ass.; 23: No. 5, 388-394 (May 1973).

A simplified method which is used by the Tennessee Valley Authority to estimate ambient concentrations of atmospheric emissions from its large fossil-fueled power plants is presented. The technique requires the use of three nomograms for the rapid graphic solution of three dispersion models (coning, inversion breakup, and trapping). A discussion of the meteorological conditions that are associated with these dispersion models, supporting appendices, and a worked example are also presented. (auth)

15510 CONTROLLING NO_x EMISSIONS FROM STEAM GENERATORS. Blakeslee, C. E.; Burbach, H. E. (Combustion Engineering, Inc., Windsor, CT). J. Air Pollut. Contr. Ass.; 23: No. 1, 37-42(Jan 1973).

Information is presented that is of interest to those individuals concerned with reducing nitrogen oxides (NO_x) emissions from gas, oil, or coal fired utility steam generators. Emission data obtained in the testing of tangentially fired utility boilers are presented. These data are related to the general body of information developed by other investigators in the areas of theoretical analysis and bench scale and full scale testing. Current design practice in relation to NO_x emission control and the continuing R&D effort required to assure acceptable control technology are discussed. (CH)

15511 SOLIDS FROM WET LIMESTONE SCRUBBING OF POWER PLANT STACK GASES. McClellan, G. H.; Mills, M. E. (Tennessee Valley Authority, Muscle Shoals, AL). J. Air Pollut. Contr. Ass.; 23: No. 2, 122-127(Feb 1973).

Optical and scanning electron microscopic examinations were made of the solids in aqueous suspensions of crushed limestone that had been used to scrub sulfur oxides from fossil-fueled power plant stack gas. Most of the sulfur was recovered as $CaSO_3 \cdot 0.5H_2O$ which formed small thin plates that settled slowly; the relatively small amount of gypsum, $CaSO_4 \cdot 2H_2O$, that was formed was present as massive crystals that settled rapidly. Scaling was encountered in significant amount only on the mist eliminator which had been washed periodically with the supernatant solution from which the solids had been settled. The scale was composed principally of massive gypsum crystals, but the plastic surfaces on which scale had formed were covered with a fine-grained mixture of fly ash and calcium sulfite that acted as the nucleating surface for the gypsum. The fly ash in the scrubber solids was present mostly as spheres, and these acted only as inert diluents of the solids. (auth)

15512 PUBLIC-HEALTH RISKS OF THERMAL POWER PLANTS. Starr, C.; Greenfield, M. A. (Univ. of California, Los Angeles). Nucl. Safety; 14: No. 4, 267-274(1973).

The results of a study comparing nuclear power plants with oil-fired plants are reviewed and assessed in terms of public-health risks. The study was undertaken as a basic contribution to the state of California's long-range planning on how best to meet the power needs of its growing population. Based on an 8-month evaluation of oil-fired and nuclear plants in urban settings, the authors conclude that the public-health risk from either type of plant is roughly comparable to the hazards to which the public is exposed by uncontrollable natural events—lightning, insect or snake bites, etc. Such deaths occur at an annual rate of approximately one per million of population. A comparison of the risk factors in routine operation of different types of power plants showed that public-health risks from nuclear plants averaged less than one-tenth of the risks from oil-fired plants. (auth)

15513 MOLTEN CARBONATE PROCESS FOR SO_2 REMOVAL FROM STACK GASES: PROCESS DESCRIPTION, ECONOMICS, AND PILOT PLANT DESIGN. Botts, W. V.; Oldenkamp, R. D. (Atomics International Div., Canoga Park, CA). J. Air Pollut. Contr. Ass.; 23: No. 3, 190-193(Mar 1973).

A molten carbonate process for removal of sulfur oxides from power plant stack gases has been under development since 1966. The preliminary development work has now been completed and a pilot plant test program is underway. A description of the process is given as well as a description of the pilot plant and results of the latest economic evaluation of the process. (auth)

INSTRUMENTATION

Radiation Detection Instruments

15514 FUNDAMENTAL STUDY ON THE PERFORMANCE OF GAMMA CAMERAS BASED ON DELAY-LINE TIME CONVERSION. Matumoto, M. (Kumamoto Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 33: No. 1, 31-43(Jan 1973). (In Japanese).

The fundamental performance (uniformity, linearity, and potential resolution) and detectability of the extent of lesion of the delay-line gamma camera were studied. The uniformity of sensitivity was ±10% within 22.5 cm diameter along X and Y axis of the crystal area. The distortion was observed on the rim around the crystal; however, linearity was good on the useable field. Potential resolution on the face of collimator were 4, 8, and 10 mm as to the pinhole, 4000 hole, and 1000 hole collimator, respectively. The resolution of the pinhole collimator was best of the three but the imaging speed was slowest. The resolution of all collimators fell off in proportion to the source-collimator distance. An experiment was performed using four kinds of nuclide (^{99m}Tc, ^{203}Hg, ^{131}I, and ^{198}Au). Detectability of ^{99m}Tc was best of the four nuclides. In a water phantom of 5 cm deep a spherical defect of 1.0 cm diameter was detected at the phantom surface and 1.5 cm diameter at the phantom bottom as for ^{99m}Tc. In a water phantom of 10 cm deep defects of 1.5 cm and 3.0 cm diameter were detected at the phantom surface as well as bottom. (auth)

General Detectors and Monitors

Refer also to abstracts 16116 and 16867.

15515 (CEA-R-4411) THERMAL NEUTRON FLUX MEASUREMENTS IN REACTORS WITH COBALT SELF POWERED NEUTRON DETECTORS. Verdant, R. (Commissariat a l'-Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 30p. (In French). Dep. NTIS (U. S. Sales Only) $3.50.

After two years of in-reactor testing of twenty self-powered neutron detectors with various diameters of cobalt emitter it was found that their sensitivity varies from 0.7 to 1.8 10^{-22} A/nv/cm when the emitter diameter increases from 1 to 2 mm; their linearity remains good down to a few percent of the reactor power; and their response time is almost instantaneous. The noise components and their evolution have been emphasized. With an integration of $4.6.10^{21}$ n/cm^{-2} the cobalt 60 current is 12 per cent of the prompt signal. Fission and capture gamma-rays induce a reverse current which has been evaluated. These two components, when they are known, do not prevent the interpretation of the prompt neutron signal. The activation of constituent parts and environment also induces reverse currents which were determined to be from 5 to 7 per cent. The cable gives a positive current. It increases artificially the detector part of 0.1 per cent per cm. In conclusion, it was determined that the noise of a self-powered neutron detector could not be represented by one value only. The main application should be flux mapping or safety in power reactors, in view of their low cost and high viability. (auth)

15516 (FRNC-TH-300) DEVICE FOR THE CONTINUOUS MEASUREMENT OF NEUTRON AND GAMMA RAY FLUXES IN REACTORS. Vulliez, P. (Grenoble Univ. (France)). 1971. 223p. (In French). Dep. NTIS (U. S. Sales Only) $13.25.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

An account is given of the experimental work in developing miniature probes for continuously measuring a neutron flux in irradiation devices and in power reactors. Two solutions were adopted, i.e., self-powered detectors and fissile deposit chambers. Particular attention was given to studying the response under the flux distribution conditions encountered in a light-water reactor operating at high power. Trials were carried out with Melusine and Siloe. An interpretation is given of the phenomena observed in the measurement of the different terms intervening in the signal of the self-powered neutron detectors (charge production calculations, emission yield, effect of the material). In the case of thermal neutrons, the ^{103}Rh and ^{51}V emitter probes present considerable interest, certain precautions having to be taken for the components and interaction with the environment. A self-powered detector made from a Zircaloy/zirconium oxide mixture enables continuous measurements to be made of the level of γ radiation flux. The fissile deposit (^{237}Np or ^{232}Th) miniaturized fission chamber enables continuous measurements to be made for neutron fluxes having energies in excess of 1 MeV. The response of these chambers, the fission rate, the sensitivity and the effect of varying the neutron spectra were studied. (FR)

15517 (INR-1459) BROAD-RANGE CURRENT-TO-FREQUENCY CONVERTER WITH ADJUSTABLE CONVERSION RATIO. Glowacki, S. W. (Institute of Nuclear Research, Warsaw (Poland)). 1973. 8p. Dep. NTIS (U. S. Sales Only) $3.00.

A simple current-to-frequency converter is described with fine regulation of current-to-frequency ratio. The converter transforms proportionally the input current in the range from 10^{-9} A to 10^{-3} A. The temperature fluctuations have no marked effect on circuit stability. The converter was developed for a gamma ionization chamber mounted in the vicinity of a reactor coolant pipe. (auth)

15518 (IPNO/HE-73-3) EFFICIENCY CALIBRATION OF A LARGE HIGH-ENERGY NEUTRON HODOSCOPE. Aubert, J. J.; Broll, C.; Coignet, G.; Favier, J.; Massonnet, L.; Smith, D. B.; Vivargent, M.; Dibon, H. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1973. 19p. Dep. NTIS (U. S. Sales Only) $3.00.

A high-energy neutron counter hodoscope consisting of a carbon converter followed by two large (useful area 1.20 × 1.24 m^2) multiwire proportional chambers each provided with two planes of wires was developed. The results of calibrations made using different neutron beam energies are presented. The points corresponding to neutron impact with the converter are reconstructed in space with a total efficiency of 5.5% ± 0.4% at 24 GeV/c (roughly constant above 8 GeV/c) and an accuracy of the order of half a centimeter. (FR)

15519 (LBL-1097) APPLICATIONS OF METHODS DEVELOPED IN HIGH-ENERGY RESEARCH CENTERS TO PROBLEMS OF MEDICINE AND DOSIMETRY. Rindi, A. Translated from Minerva Fisiconucl.; 15: No. 4, 159-167(1971). 14p. Dep. NTIS $3.00.

Topics include wire spark chambers with magnetostriction readout, proportional wire chambers, the use of spark chambers for locating gamma-ray or x-ray emitters in the human body, the use of spark chambers for locating the stopping region of negative pions, and the use of spark chambers for neutron dosimetry using polyethylenes sandwiches. (WHK)

15520 (NIIAR-106) FISSION FRAGMENT GAS SCINTILLATION DETECTORS. Kroshkin, N. I.; Kormushkina, G. A.; Starostov, B. I.; Shipilov, V. I. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 18p. (In Russian). INIS.

Gas scintillation detectors are described which had been used in spectral determinations of prompt neutron fission by the time-of-flight method in the nanosecond region. Neutron spectra and their average number $\bar{\nu}$ were obtained for the spontaneous fission of ^{244}Cm, ^{252}Cf, and the induced fission of ^{245}Cm by thermal neutrons. A He-filled detector was used in measurements with activities ~10^8 α-particles/sec at a resolution time of the spectrometer of 3.5 ns. The amplitude and time properties of a gas scintillation detector were satisfactorily matched in a Xe-filled detector. The energy resolution attained for the kinetic energies of fission fragments was 1.5 times lower than the resolution obtained using semiconductor detectors. The time resolution was 2.5 ns, as judged from gamma quanta fission of ^{252}Cf. (tr-auth)

15521 (RT/EL-(73)3) MEASUREMENTS OF THE WIDENING OF THE LINES CAUSED BY THE ENTRAPMENT OF A CHARGE IN GERMANIUM CRYSTAL DETECTORS. Barlocci, A.; Coiante, D.; Emiliani, G.; Parisi Presicce, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 Jan 1973. 44p. (In Italian). Dep. NTIS (U. S. Sales Only) $4.25.

Resolution measurements of lithium-drifted germanium detectors are described. The experimental FWHM does not agree with calculated values. The difference can be ascribed to charge trapping effects. A measure of FWHM versus the applied electric field supports this hypothesis. (auth)

15522 SPARK DETECTOR WITH PERMANENT REGISTRATION. Palacios Hernandez, N. G. Mexico City; Universidad Nacional Autonoma de Mexico (1973). 62p. (In Spanish).

Thesis.

The design and development of a spark detector with permanent registration is described. The historic development of spark detectors is first compiled. A detailed description is then given of the different parts of the detector with emphasis on the method

for producing cathodes with distinct thicknesses. The pulse attenuator circuit is considered in detail. The optimum conditions of geometry, voltage, and distance between electrodes are determined. The theory of spark detectors is considered with a description of the Townsend mechanism at low pressures and the corona effect produced at atmospheric pressures. A possible explanation is given of the streamer theory and the sputtering effect is studied. Photographs of the cavities are shown and the optimum thicknesses for Cu and Au cathodes are given. (tr-auth)

15523 γ SCINTILLATIONS IN ACTIVATED ALKALI IODIDES. Intenberg, L. E.; Berzinya, B. Ya. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 45-47(1973). (In Russian).

The form of γ-scintillations was investigated in KI(Tl), RbI(Tl), and NaI(Tl) crystals in the temperature region from 90° to 300°K. It was established that in KI(Tl) and NaI(Tl) crystals at 250 to 300°K the γ-scintillations are caused by Tl luminescence; in the temperature region from 90° to 150°K in KI(Tl), RbI(Tl), and NaI(Tl) the γ-scintillations are caused by self-trapped excitons. (auth)

15524 APPLICATION OF TRANSVERSE-WELL-TYPE SCINTILLATOR FOR MEASURING THE RADIOACTIVITY OF FLOWING LIQUIDS IN THE GEL FILTRATION TECHNIQUE. Ditrol, F.; Peter, F.; Lampe, L.; Lakatos, L. (Orvostudomany Egyetem Szueleszeti, Debrecen, Hungary). Izotoptechnika; 16: No. 4, 223-227(Apr 1973). (In Hungarian).

The design and operation of a liquid flow scintillation cell are described. (auth)

15525 POSITION SENSITIVE PROPORTIONAL COUNTER. Varga, D. Atomki (At. Kut. Intez.). Kozlem.; 15: No. 1, 17-21 (1973). (In Russian).

Two different types of position-sensitive proportional counters have been built. The accuracy in the localization of particles given by the first counter working with independent anode wires amounts to 1.5 mm. The spatial resolution of the second counter working with high resistance spiral cathode is 0.4 mm. (auth)

15526 RADIATION MONITORING: METHODS AND INSTRUMENTS. Part 2. Monitoring Instruments. Bullen, M. A.; Garrett, J. A. (Bristol General Hospital, Eng.). Bio-Med. Eng.; 8: No. 6, 250-256(Jun 1973).

A brief outline review is made of the variety of monitoring instruments available under the following headings: bulk detectors such as ionization chambers, photographic films, thermoluminescent dosemeters and current-mode silicon detectors; and pulse detectors such as Geiger–Müller counters, scintillation counters and pulse-mode solid-state counters. Typical examples of the various types are described, and particular reference is made to personal dosimeters and alarms. A manufacturer/product table is presented. (UK)

15527 SOLID STATE TRACK DETECTOR: CELLULOSE TRIACETATE. Vareille, J. C.; Teyssier, J. L. (Univ., Limoges, France). Radioprotection; 7: No. 4, 215-228(1972). (In French).

The utilization of cellulose triacetate (Bayer triafol T.N.) as a solid state track detector for charged particles (α particles, californium fission fragments) was studied. It was demonstrated that the etch rate ratio R_T increases with decreasing temperature and increasing etching reagent concentrations. The presence of a plastifier in the detector material increases R_T by a factor of 2.5. The activation energy for the potassium hydroxide/damaged zone reaction increases with decreasing linear energy transfer from the charged particle. The maximum α particle energy recorded was 4 MeV, the etching reagent being 4N KOH at 60°C. The discrimination between α particles of different energy can be made using this detector with a 500 keV resolution. (FR)

15528 THEORETICAL ASPECTS REGARDING PROTON RECOIL COUNTERS. Leonidou, D. J. (National Technical Univ., Athens). J. Inst. Nucl. Eng.; 14: No. 2, 39-41(Mar 1973).

Some theoretical aspects are formulated taking into account multiple scattering of neutrons on hydrogen nuclei, occupying a limited volume, in a proton recoil neutron counter. An increased number of protons produced per sec with energy in a certain energy interval E to E + dE is considered. A neutron may mobilize more than one proton, with energy in the range of interest before escaping from the volume occupied by the hydrogen nuclei. (auth)

15529 IMPROVEMENTS IN OR RELATING TO SIMULATED RADIOACTIVITY MONITORING ARRANGEMENTS. Starks-Field, A. B.; Tyler, R. A.; De Tullio, L.; Schelisch, E. F. (to Marconi Co. Ltd.). British Patent 1,311,615. Mar 1973. Filed date 26 Mar 1971. 7p.

A simulated radioactivity monitoring system for training personnel is described, comprising an array of field instruments each capable of giving an indication of radiation strength on receipt of a data signal from a base station, together with means for determining the position of each instrument, and means at the base station for transmitting to each instrument a data signal representing the assumed radiation level at the location of the instrument. Normal instruments are used, but the normal radiation measuring circuits are replaced by electronic circuits capable of distinguishing a signal addressed to the instrument by the base station and utilizing the data to provide to the trainee a response similar to that which would be given by the instrument in a real situation. In order to locate the field instruments, slave stations may be provided. Provision may also be made for ultrasonic sonar distance measuring devices and analogue memory devices. (UK)

15530 APPROXIMATIONS OF THE RELATION SPEED–ELECTRIC FIELD FOR CHARGE CARRIERS IN Ge(Li) COAXIAL DETECTORS. Poenaru, D. N. Electrotehnica (Bucharest); 21: No. 2, 80-85(Feb 1973). (In Rumanian).

Two simple analytical approximation expressions of the dependence of the charge carrier speed on the intensity of the electric field are proposed, which permit the calculation of the shape of the electric impulses supplied by Ge(Li) coaxial detectors in response to nuclear radiations. (auth)

15531 UNIVERSAL COUNTER FOR NUCLEAR MEASUREMENTS. Bibok, G.; Kertesz, Z.; Mathe, G.; Paal, A. Atomki (At. Kut. Intez.) Kozlem.; 15: No. 1, 49-57(1973). (In Hungarian).

A universal counter, developed at the Electronic Department of ATOMKI, is described. The unit contains an amplifier and a single-channel analyzer, a counter and digital ratemeter, and a low- and high-voltage power supply. Owing to its small size, reliability and versatility the instrument can be used for nuclear measurements in research laboratories, as well as for medical and industrial purposes. (auth)

15532 2,4,6-TRISUBSTITUTED PYRIDINES. Synthesis, Fluorescence, and Scintillator Properties. Barrio, M. C. G.; Barrio, J. R.; Walker, G.; Novelli, A.; Leonard, N. J. (Univ., Buenos Aires). J. Amer. Chem. Soc.; 95: No. 15, 4891-4895 (25 Jul 1973).

The synthesis of 2,4,6-trisubstituted pyridines from chalcones and formamide, under the conditions of the Leuckart reaction, is described. In contrast to 2,4,6-triphenylpyridine, which yields 2,4,6-tricyclohexylpiperidine on catalytic hydrogenation with platinum in acetic acid, 2,6-diphenyl-4-(p-methoxyphenyl)pyridine and 2,6-di(p-methoxyphenyl)-4-phenylpyridine yield 2,6-dicyclohexyl-4-(p-methoxyphenyl)pyridine and 4-cyclohexyl-2,6-di(p-methoxyphenyl)pyridine, respectively. Physical and chemical evidence firmly established the proposed structures. The ultraviolet absorption and fluorescence excitation and emission spectra of the substituted pyridines synthesized showed structure and pH dependence. Most of the compounds showed extremely high fluorescence intensity, being readily visible at concentrations even below 1×10^{-9} M. Initial studies demonstrated that certain 2,4,6-triaryl substituted pyridines show promising potential as scintillators that will allow liquid scintillation counting to be carried out at high efficiency in strongly acidic solution. (auth)

15533 POSITRON/SCINTILLATION CAMERA DATA ACQUISITION AND DISPLAY SYSTEM (6 MAR 1973) (ENGINEERING MATERIALS). (California Univ., Livermore. Lawrence Livermore Lab). (CAPE–2343).

26 Drawings.

15534 NEUTRON DETECTOR OF THE TRACK-DAMAGE TYPE. Bredoux, F. J. M.; Mercier, C. A.; Philpot, G. A. (To Eastman Kodak Co.). U. S. Patent 3,735,135. 22 May 1973. Priority date 4 Nov 1969, France. 8p.

A neutrographic product comprising a recorder layer capable of undergoing selective radiation-damage (dielectric track detector) and a converter layer comprising a composition dispersed in a binder, said composition being capable of producing a nuclear (n,α) reaction, is described. (Official Gazette)

15535 METHOD FOR THE ACCELERATION OF IONS IN LINEAR ACCELERATORS AND A LINEAR ACCELERATOR FOR THE REALIZATION OF THIS METHOD. Bomko, V. A.; Revutskii, E. I.; Rudiak, B. I.; Pipa, A. V. British Patent 1,311,616. 28 Mar 1973. Filed date 5 Apr 1971. 5p.

A method of accelerating ions in a linear accelerator of the drift cavity type is described, employing a standing rf wave, enabling the final energy of the accelerated ion beam to be varied continuously by adjusting the extent of a region with uniform accelerating field distribution along the cavity axis. A linear accelerator employing this method is also described. This comprises a cavity resonator with drift tubes, tuners arranged on a

side wall of the resonator, together with an additional tuning means for adjustment of the extent of the region with uniform distribution of the accelerating field. This additional tuning means takes the form of a movable conducting post installed on an end wall of the resonator. (UK)

15536 DOUBLE ALPHA PARTICLE IONIZATION CHAMBERS WITH A SAMPLE CHANGEOVER DEVICE. Bimbot, R.; Deprun, C.; Gardes, D.; Le Beyec, Y. (Paris Univ., Orsay, France). Rev. Phys. Appl.; 8: No. 1, 97-98(Mar 1973). (In French).

A device, designed to measure successively the alpha activity of eight samples, two of them being counted simultaneously, is described. (FR)

15537 NEW PROCEDURE FOR DETECTING CHARGED PARTICLES. Monnin, M.; Blanford, G. (Clermont-Ferrand Univ., France). Compt. Rend., Ser. A, B; 276: No. 10, 389-391(5 Mar 1973).

A new procedure is presented for detecting charged particles by radiografting acrylic acid onto a basic polymer (cellulose triacetate) irradiated by ^{252}Cf fission fragments. The copolymer formed is colored with rhodamine B. Observations of the tracks are then made using optical transmission and ultraviolet fluorescence microscopy. (FR)

15538 METHOD OF ANALYZING THE ENERGY AND SPATIAL DISTRIBUTIONS OF SECONDARY ELECTRONS EMITTED BY MONOCRYSTALLINE TARGETS BOMBARDED WITH 10 TO 100 keV IONS. Mischler, Josette; Nicole, C.; Jean, F. (Univ., Toulouse). Compt. Rend., Ser. A, B; 276: No. 10, 381-384(5 Mar 1973). (In French).

A movable 127° electrostatic selector which operates under vacuum and enables the energies of secondary electrons ejected in various directions to be analyzed is described. Such a system enables the energy spectrum of electrons emitted with energies ranging from 0 to 200 eV to be recorded. This system also permits the variation in the number of electrons emitted to be studied as a function of the azimuth of the receiving plane for a given energy. (FR)

15539 METHOD FOR THE MANUFACTURE OF A NUCLEAR DETECTOR DEVICE. Meuleman, J. (to La Radiotechnique Compelec). French Patent 2,120,296. 18 Aug 1972. Filed date 29 Dec 1970. 9p. (In French).

A method is proposed for the manufacture (diffusion and epitaxial depositing) of a nuclear detector device. The device is provided with a semiconductor crystal in which two surface regions (composed of p and n type material respectively) separated by an intrinsic region are formed. An n type region is formed in a p type crystal (silicon); an intrinsic region is then formed by diffusing a compensating impurity into the crystal across the whole of the n type region and across at least part of the p type region adjacent to the n type region. The n type region is obtained by the controlled diffusion of a selected impurity from the fifth column of the periodic table to a very shallow depth. Li is used as the compensating impurity. The thickness of the n layer can be well defined (this layer can be made extremely fine, approximately 1 μ). The series resistance and thus the noise is reduced because the n zone contains both the doping and compensating impurity. The external zone is dished to form the input window, and to reduce the absorption. (FR)

15540 USE OF CHANNEL MULTIPLIER ARRAYS. Chalmeton, V. (Laboratoires d'Electronique et de Physique Appliquee, Limeil-Brevannes, France). Acta Electron.; 16: No. 1, 73-84 (Jan 1973). (In French and English).

In neutron radiography, the detectors used require a flux of the order of 10^9 to $10^{10} n/cm^{-2}$ to produce a high-quality image, whereas nuclear reactors provide only $10^7 n/cm^{-2}\ s^{-1}$. In order to reduce exposure times and to increase the output luminance, an attempt was made to convert the neutrons into electrons and to amplify the electron flux obtained, a microchannel plate being used in conjunction with a gadolinium converter working in the transmission mode. An image intensifier of this type having a useful diameter of 120 mm is described. A microchannel plate (having individual microchannels of 100 μm diameter) exposed to a $2.10^8 n/cm^{-2}$ flux enabled an image with a resolution of 4 line pairs/mm to be obtained. (FR)

15541 LIGHT AND COMPACT X-RAY IMAGE READ-OUT SYSTEM FOR SPACE APPLICATIONS. Morton, J. M.; Parkes, W. (Univ. of Leicester, Eng.). Acta Electron.; 16: No. 1, 85-100(Jan 1973). (In French and English).

Conventional methods of reading the output of electron multiplier array plates convert the electron image to visible light and then record by photographic film or electron beam scanning. Leicester University X-ray Astronomy Group has developed an alternative method which should be especially applicable to rocket and satellite borne x-ray telescopes. The output electron pulse is collected on a wire grid whose elements are connected in series by capacitors. Incoming charge is divided by the capacitance in such a way that the relative pulse heights at the ends of the grid identify the arrival position at the photo-cathode. (FR)

15542 GAS FLOW COUNTING CHAMBER FOR IONIZING RADIATION. Kimmel, H. German Patent 1,589,996. 13 Aug 1970. Filed date 1 Feb 1967. (In German).

A gas flow chamber for direct or indirect ionizing radiation is characterized by the fact that the interior space is connected to the environmental atmosphere by means of a plug. (TSS)

15543 USING THE DECAYS OF GOLD-198 AND VANADIUM 52 TO DETERMINE RESOLVING TIME IN G-M COUNTING. David, L.; Mazur, C.; Medina, R. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Health Phys.; 25: No. 2, 194-196(Aug 1973).

It is shown that the resolving time (τ) of a GM detection system can be represented by a polynomial of the third degree in $^*N_i(t_i)$ and $N_i(t_i)$ respectively, (where $^*N_i(t_i)$ is the measured counting rate at time t_i and $Ni(t_i)$ is the true counting rate at that time), if the corrections for the loss of counts is determined by the equation $\{^*N_i(t_i) = [N_i(t_i)/1 + \tau\ (N_i)N_i(t_i)]\}$ in the range $0 \leq {}^*N_i \leq 3.10^5$ counts/min. An intercomparison of the determination of τ using ^{198}Au and ^{52}V by this method is made and it is demonstrated that the correction curves of the resolving time are identical within the limit of confidence. (UK)

15544 PROPERTIES OF A LIQUID IONIZATION CHAMBER IRRADIATED WITH FAST NEUTRONS. Horneck, F. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Frankfurt am Main). pp 319-327 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The ionization current of fast neutrons produced by a 600 kV accelerator was measured by a parallel-plate ionization chamber filled with a carefully cleaned dielectric liquid (n-hexane). Its specific conductance was $\leq 3 \times 10^{-18}$ mho/cm. The experimentally obtained ionization-current curve consists of two distinct portions. The curve is not linear when the secondary recombination is considerable, up to some limiting electric field strength, in this case up to ≤ 2 kV/cm. For electric field strengths above 2 kV/cm the ionization current increases linearly, because more and more ions escape the primary recombination. But the ionization current did not reach a saturation value, which was, therefore, calculated using an approximation of the Jaffé theory. Knowledge of this saturation value of the ionization current and of the dose rate in the ionization chamber make it possible to state the average energy W necessary to produce one ion pair in the liquid. The experiments yielded a W-value for n-hexane of 26 eV ± 14%. The measurements with the liquid ionization chamber had a reproducibility of ±3%. The lowest detectable sensitivity was about 20 mrem/h at an electric field strength of 2 kV/cm. (auth)

15545 COLLECTION EFFICIENCY OF AN IONIZATION CHAMBER FILLED WITH A LIQUID DIELECTRIC AND SUBJECTED TO A SINGLE RADIATION PULSE OR TO CONTINUOUS RADIATION. Casanovas, J.; Grob, R.; Magne, R. M.; Blanc, D.; Mathieu, J. (Univ., Toulouse). pp 329-339 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The results of experiments relating to the response of ionization chambers (with plane or cylindrical electrodes) filled with a liquid dielectric (pure alcane or a mixture of alcane and carbon tetrachloride) and subjected to a single, short (50 ns) X-ray pulse or to a continuous stream of electrons are presented. They show that formulas similar to those derived by Boag for gases make it possible to calculate the collection efficiency of a liquid-filled ionization chamber with plane or cylindrical geometry; the agreement with experiment is good. (auth)

15546 APPLICATION OF THE IONOGRAPHIC TECHNIQUE TO ANALYSIS OF THE DISTRIBUTION OF FISSION EVENTS IN FUEL ELEMENTS. Mourgues, M.; Renavot, J. M. (CEN, Cadarache, France). pp 627-650 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Ionographic techniques provide a means of studying interactions between ionizing particles and certain dielectric media on a microscopic scale and in a very selective manner. They permit such fine-structure analysis of fuel as the measurement of neutron flux gradients over a distance as small as the radius of the Rapsodie fuel pins (a few millimeters); this is done by using thin Makrofol detectors to record fission fragments emitted by the plane faces of uranium oxide slugs. A new technique for using ionographic detectors has been developed in order to broaden the field of application of this analytical technique; it is based on the analysis of radiographic films by densitometry (Marius high-temperature reactor experiments). The characteristic feature of the ionographic detection method is that the effect studied is recorded directly, without the occurrence of appreciable interaction with the neutron flux and, therefore, without disturbance of the latter. Mention is also made of the insensitivity of Makrofol to other sources of radiation, particularly alpha particle emission from fissionable fuels. (auth)

15547 LARGE AREA FOCUSING COLLECTOR FOR THE OBSERVATION OF COSMIC X RAYS. Gorenstein, P.; DeCaprio, A.; Chase, R.; Harris, B. (American Science and Engineering, Cambridge, Massachusetts 02139). Rev. Sci. Instrum. 44: No. 5, 539-545 (May 1973).

A large area focusing x-ray collector constructed for a sounding rocket is described. The instrument consists of nested reflecting plates that are curved slightly in one dimension to form a set of parabolas with a common focus. An array of plates such as the one in the sounding rocket focuses a parallel beam of x-rays to a line. The reflecting surfaces are commercial float glass with an evaporated metallic coating such as gold or nickel. With a gold coating the effective area of the rocket collector is about 250 cm^2 for 0.3 keV x rays and about 150 cm^2 at 1.2 keV. Its angular resolution is a few arc minutes and field of view is about $\pm 0.75°$ (full width at half maximum). The collector performed successfully during a sounding rocket flight. (auth)

Radiation Dosimeters

Refer also to abstracts 15666 and 15676.

15548 (STI/PUB-311) DOSIMETRY IN AGRICULTURE, INDUSTRY, BIOLOGY, AND MEDICINE. Proceedings Series. Proceedings of a Symposium Held in Vienna, Austria, April 17–21, 1972. (International Atomic Energy Agency, Vienna (Austria)). Apr 1973. 695p. (In Several Languages). (CONF-720411–). IAEA $26.00.

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972).

Separate abstracts were prepared for the 59 papers presented. (WHK)

For abstracts of individual papers see: 15544–15546, 15559–15610, 15666, 15669, 15676, and 17262.

15549 DESIGN AND CONSTRUCTION OF A PERSONAL RADIOACTIVITY DOSIMETER. Parra, E. R. Mexico City; Instituto Politecnico Nacional (1973). 94p. (In Spanish).

Thesis.

A personal radioactivity dosimeter, based on a G-M tube, is described. The dosimeter is constructed of commercially available units. The conditions imposed on the dosimeter are outlined and the selection of the components to fulfill those conditions are described. The laboratory tests on the prototype are described. (JSR)

15550 FOCUSING, CALIBRATION, AND FIRST TESTS IN SPECTROGRAPH(IV). Ugalde, F. A. Mexico City; Universidad Nacional Autonoma de Mexico (1973). 41p. (In Spanish).

Thesis.

The provisional mounting of the spectrograph(IV) is described and some necessary adjustments made principally in the collimator grating of the beam are reported. The general definitive plane of the instrument and the plane of the provisional bombardment line are given. The process followed in the focusing of the instrument is described and the results are analyzed. The technique used for calibration is included and the range-energy graphs calculated for nuclear plates used in the instrument and which are used to identify the type of particle by the length of the track observed in the emulsion are given. The exposures made to study the spectra of the nuclear reactions $^{45}Ca(p,\alpha)^{45}K$ and $^{48}Ca(p,p')^{48}Ca$ are reported. The results from the first reaction were disappointing as it was not possible to bombard at an adequate energy level of 12 MeV. In the second reaction 7 excitation levels were observed, but no new data were obtained. (JSR)

15551 ADVANCES IN NEUTRON DOSIMETRY. Widell, C. O. (Aktiebolaget Atomenergi, Stockholm). Radioprotection; 7: No. 4, 253-268(1972).

Two instruments are described: a silicon diode dosimeter for fast neutrons and a neutron dose rate meter 2202°C. In the first instrument, changes in the current voltage characteristics of a small silicon diode are used to measure fast neutron doses. This change is permanent and it is thus possible to integrate doses over long periods of time. Doses from a few rads up to several thousand rads can be measured and the information stored is not destroyed during readout. The second instrument is a neutron dose rate meter designed for radiation protection monitoring around reactors, accelerators, and other neutron producing equipment. This instrument can be used to measure dose rates in mrem/h for energies ranging from thermal energies to 17 MeV. (FR)

15552 METHOD AND APPARATUS FOR THE MEASUREMENT OF MIXED GAMMA-NEUTRON RADIATION DOSE EQUIVALENT. Pszona, S. U. S. Patent 3,729,631. 24 Apr 1973. Filed date 22 May 1970. 6p.

A method and apparatus for measuring mixed gamma-neutron dose equivalent by determining a current difference between the output of an ionization chamber and a scintillator which latter preferably comprises an organic compound and has a photomultiplier tube operatively connected therewith is described. (Official Gazette)

15553 THERMOLUMINESCENT RADIATION DETECTOR. Lucas, A. C. (To VLN Corp.). U. S. Patent 3,735,134. 22 May 1973. Filed date 10 Apr 1970. 10p.

A radiation detector having hot-pressed thermoluminescent material disposed in close proximity to a heater element, both supported by electrical connecting pins passing through a base of a glass envelope enclosing the same in a gaseous environment of high thermal conductivity or of an open glass cylinder leaving the same exposed in an air environment, is described. Variations may include a heater wire threaded through a cylinder of hot-pressed thermoluminescent material or a flat planar heater and planar chip of hot-pressed thermoluminescent material. (Official Gazette)

15554 CONNECTION DEVICE FOR THE DIGITAL MEASUREMENT OF DOSES WITH A RADIATION DETECTOR AND ELECTROSTATIC RELAYS. Pawelzik, J. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,589,868. 11 Jun 1970. Filed date 12 Dec 1967. (In German).

A connection device for the digital measurement of doses by means of a radiation detector and an electrostatic relay transforming the impulses emitted by the radiation detectors in a quantity of electrostatic charge equivalent to a preestablished number of impulses of measurement is described. It can be used, for example, for the surveillance of the environment of nuclear installations for the determination of the dose produced by direct gamma irradiation. (TSS)

15555 ADIABATIC CALORIMETER FOR MEASURING X-RAY DOSE IN SILICON. Murray, K. M.; Attix, F. H. (Naval Research Lab., Washington, DC). Health Phys.; 25: No. 2, 169-171(Aug 1973).

An adiabatic calorimetric dosimeter, designed for measuring doses $>10^2$ rad (silicon) delivered in a brief pulse (~1 sec or less), is described. The important features incorporated in the design are: (1) The core and surrounding mantle are both made of the same material (silicon) so that radiation heating of the jacket closely approximates that of the core to minimize heat transfer from one to the other. (2) Nearly spherical symmetry provides isotropic response. (3) A calibrated thermistor is used for temperature sensing, constituting <1% of the core mass, thus perturbing the dose measurement to a negligible degree. (4) The specific heat of pure polycrystalline silicon from which the calorimeter is made is well known, so that through the adiabaticity of the measurement, an absolute determination of dose is provided without need of calibration either by a standard radiation field or through an electrical heating system. (5) The rapidity of radiation heating from an intense x-ray pulse eliminates the need for evacuation of air from the calorimeter container to provide adequate thermal insulation. (UK)

15556 THERMOLUMINESCENT DOSIMETERS. 2. The Study of Characteristics of the Cleaved LiF Crystal for the use of Personnel Monitoring. Takaku, Y. (Fukushima Medical Coll., Japan); Nakajima, T.; Kato, Y. Nippon Igaku Hoshasen Gakkai Zasshi; 32: No. 6, 551-555(Sep 1972). (In Japanese).

The characteristics of cleaved LiF (about $10 \times 10 \times 1.5$ mm in size, available from Harshow Chemical Co.) were studied. These included fading in the dark at room temperature; dose dependence; the standard deviation of 10 dosimeter measurements from a batch

of 100 pieces at the exposure level of 10,100 and 1,000 mR; potentialities for repeated use; energy dependence; and angular dependence of the sensitivity for 29 keV effective energy. Acrylite holders were made for this experiment. The reader used was Harshaw Model 2000 analyzer. The annealing procedure was 400°C for 1 h followed by 2 h at 100°C for pre-irradiation, and 100°C for 10 min for post-irradiation and pre-reading. At the beginning of the experiment, the standard deviation in sensitivity for a batch of 100 pieces was observed to be about 30%, so the calibration of the dosimeters and the corrections for readings with their sensitivities had to be practiced. The estimated lower detectable limit for the combination of the dosimeter and reader was 30 mR with the standard error of ±50%. With this sensitivity and good energy dependence this system is suitable for the measurement of high exposure levels expected in some clinical x-ray examinations. (auth)

15557 DOSIMETRY OF IONIZING RADIATIONS. Dejehet, F. (Univ., Louvain, Belgium). Rev. Quest. Sci.; 144: No. 2, 169-188 (1973). (In French).

The measurement of ionization produced by radiation in a gas constitutes the principal method for the determination of exposure doses and absorbed doses. The theory of the ionization chamber gives a relation that makes possible an evaluation (determination, estimation) of the absorbed dose in the irradiated medium starting with that absorbed, and thus measured, by the detector. In its general form, this theory is applicable to any dosimeter, regardless of its dimensions and its physical state. The formulas permitting the calculation of the absorbed dose are given for the various conditions of irradiation and the transposition to the case of any dosimeter whatever is indicated. (tr-auth)

15558 DEVICE FOR LOADING THERMOLUMINESCENT DOSIMETRY POWDER INTO CAPSULES. Gorbics, S. G.; Attix, F. H. (Naval Research Lab., Washington, DC). Phys. Med. Biol.; 16: No. 4, 577-579(Jul 1973).

The advantages of loose powders over other forms of thermoluminescent dosimetry materials are their low cost per unit mass of sensitive material, the convenience of being able to adjust the amount of material used and the ability to vary the shape or thickness of the dosemeter for specific applications. However loose powders do present difficulties in handling. An apparatus for conveniently loading large numbers of capsules with small powder samples prior to irradiation with a good degree of accuracy is described. The apparatus has been used for loading CaF_2 : Mn and LiF (TLD 700) powders of 100 to 200 mesh with satisfactory results but results with lithium borate were unsatisfactory due to the hygroscopic nature of the powder. (UK)

15559 ASPECTS OF DOSIMETRY DEVELOPED FOR MEDICAL RADIATION APPLICATIONS. Laughlin, J. S.; Holt, J. G.; Mohan, R.; De Celemente, A. (Sloan-Kettering Inst. and Mental Hospital, New York). pp 11-36 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

A review of certain aspects of dosimetry developed for specific medical applications is given. These include applications pertinent to therapeutic uses of radiations, diagnostic uses of x rays, and diagnostic uses of radionuclides. The nature of the applications to be reviewed include calibration systems developed in our hospital in connection with these uses of radiation, and developments of computerized dosimetry systems to facilitate the more extensive use of radiation for treatment purposes. (auth)

15560 MEDICAL DOSIMETRY TECHNOLOGY IN DEVELOPING REGIONS OF THE WORLD. Levan, J. H. (Veterans Administration Hospital, Hines, IL). pp 37-47 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The International Atomic Energy Agency and the World Health Organization have been quite active in developing regions of the world with their technical assistance programs. One of the aims has been that of improving the inadequate facilities and techniques employed in medical radiation dosimetry. The resources of these international organizations, however, are quite limited, and relatively little has been done to update the techniques and instruments still being used. In many developing regions radiotherapy has existed for many decades, but very little progress has been made in radiation dosimetry. A number of existing conditions need to be improved and could be readily corrected with minimal active assistance from institutions in the developed countries of the world. Many professional organizations could certainly serve as clearing houses for various institutions or individuals willing to help a hospital in any developing country. International comparisons of radiation dosimetry between radiotherapy centers in advanced countries have been a common practice. These comparisons, however, are seldom extended to include developing countries where neither technical know-how, nor elaborate equipment are available, and where the needs for more accurate dosimetry are desperate indeed. This type of activity could widen common scientific horizons and would certainly enhance understanding between all peoples of the world. (auth)

15561 USE OF RPL GLASS DETECTORS FOR ABSORBED DOSE MEASUREMENT IN RADIOTHERAPY. Labau, V. (Inst. for Atomic Physics, Bucharest); Nicolae, M.; Matache, M.; Spiridon, V. pp 51-58 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Since RPL glass detectors are of a small size, have a high stability to environmental factors and offer the possibility of covering a wide range of doses, they are well suited for irradiation control in radiotherapy. Some results on the use of RPL glass detectors in small rod form for absorbed dose measurements on phantoms with a view to their application for routine dose measurements in radiotherapy are given. The experiments were performed by using Romanian RPL glass detectors. The level of accuracy allowed by this method in x-ray and γ-ray radiotherapy was investigated. Comparison was made with results obtained using a small ionization chamber. It was shown that the measurements made using RPL glass detectors are reproducible and the level of accuracy is good, the experimental error not exceeding 5%. Practical methods of applying the detectors in certain cases of dose measurement in vivo are described. (auth)

15562 RADIOPHOTOLUMINESCENT GLASSES AS DOSIMETERS IN RADIOECOLOGICAL STUDIES. Chapuis, A. (CEN, Fontenay-aux-Roses, France); Chartier, M.; Francois, H.; Soudain, G.; Grauby, A.; Fabries, M. pp 59-66 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

A study, which began at Cadarache on July 11, 1969, of the long-term effects of massive and chronic gamma irradiation on a particular ecosystem is described. The authors used a strong ^{137}Cs source, which was installed in a small scrub-covered valley. In such studies the dosimeters have to be insensitive to external physical factors such as light, temperature, and humidity. The dose rates varied from about 0.1 to 100 rad/h. The authors selected RPL glasses for use as dosimeters, paying special attention to their stability with respect to the considerable temperature variations recorded in the irradiated zone. (auth)

15563 FADING OF THE RADIOPHOTOLUMINESCENCE OF SILVER ACTIVATED GLASS DOSIMETERS. Barthe, J. (Univ., Toulouse); Blanc, D.; Wauquier, J. M.; Commanay, L.; Francois, H. pp 67-73 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The experimental arrangement employed in studying the nature of the fading of the fluorescence of French silver-activated RPL glasses is described. After irradiation, the fluorescence fading curve has at least three exponential components, the amplitudes of which depend on the dose. This work was done with a view to developing a glass dosimeter reader which will be more sensitive than the present systems. (auth)

15564 USE OF VARIOUS DOSIMETERS FOR THE MEASUREMENT OF RANDOM FLUCTUATIONS OF THE DOSE DISTRIBUTION IN COMMERCIAL-SCALE FOOD IRRADIATION. Ehlermann, D. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). pp 77-83 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Several dose distributions were measured by the use of different dosimeters. The data were statistically analyzed by their deviation from the normal distribution. If the number of dosimeters used is large enough, the shape of the distribution leads to the extrapola-

tion of limit values. The resulting uniformity ratios are lower than those calculated from the analysis of D_{min} and D_{max} distributions. (auth)

15565 DOSIMETRIC METHODS AND FOOD IRRADIATION. Kets Neels, G.; Van de Voorde, M.; Tobback, P. (Katholieke Univ., Leuven, Belg.). pp 85-89 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The treatment of foodstuffs with ionizing radiation calls for appropriate dosimeters. The first studies in dosimetry, which date from 1895 and the discovery of x rays, formed the basis for subsequent qualitative studies. Since then many types of dosimeter have been developed, with different laboratories often using their own methods; there has accordingly arisen a need for unification. The present situation as regards the dosimetric methods used in food irradiation is reviewed. Different dosimeters with their advantages and disadvantages are described, and what is required of the dosimeters used in food irradiation is stated. An account is given of the work which has been or is to be done at the industrial food preservation laboratory of the "Katholieke Universiteit" of Louvain, the purpose of which is to study thoroughly the composition of foodstuffs and develop dosimeters possessing the required characteristics. (auth)

15566 SMALL VOLUME NEUTRON AND GAMMA-RAY REACTOR DOSIMETRY FOR VARIOUS IRRADIATION EXPERIMENTS. Schneider, W. (Kernforschungsanlage Juelich GmbH, Ger.). pp 91-99 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Different wrappings are specified for irradiation as well as for the post-irradiation treatment of activation detectors in different applications in reactor irradiation experiments. The detector irradiation techniques for steel irradiation are briefly reported. The measuring equipment and the method of evaluation for activation detectors as neutron fluence monitors are described. The capability of some regularly used neutron activation detectors as well as of solid-state and chemical gamma-ray dosimeters is described. Some problems under investigation are the development of useful high-temperature activation detectors, the prediction of flux and fluence values for particular cases of irradiation, and the knowledge of neutron spectra which is required as essential information on irradiation conditions. (auth)

15567 CONTRIBUTION OF THE WHO-IAEA REGIONAL REFERENCE CENTER TO THE IMPROVEMENT OF CLINICAL DOSIMETRY AND RADIOLOGICAL PROTECTION IN ROMANIA. Milu, C. G.; Racoveanu, N. (Inst. of Hygiene and Public Health, Bucharest). pp 101-109 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The organization of the WHO-IAEA Regional Reference Centre for Secondary Standard Radiation Dosimetry is described. The work of the Centre is focussed on introducing calibration of clinical and radiological protection dosimeters, on improving dosimetry in x-ray therapy by working toward a better estimation of deep doses, and on carrying out research in clinical dosimetry. The procedure of calibration of a clinical dosimeter using the WHO-IAEA standard (a Kustner-Pychlau free air chamber) is described. Some data concerning the calibration of a number of dosimeters are given. The need for standardized procedure when measuring exposures is stressed as only in this way can reliable results be obtained. The use of the Centre's facilities in helping to introduce TLD in clinical and radiological dosimetry is described. Using the Centre's calibration facilities, the authors describe some of the results previously obtained by the introduction of TLD in clinical and radiological protection dosimetry. (auth)

15568 EFFECTS ON DOSIMETER READING DUE TO HAVING DIFFERENT CONDITIONS AT CALIBRATION AND IN USE. Pychlau, P. (Physikalisch-Technische Werkstaetten, Freiburg i.B.). pp 111-119 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Before their use in experiments dosimeters are normally compared against primary or secondary standards. Each dosimeter has an energy dependence which is determined during the calibration procedure both for monoenergetic photons from gamma sources and for bremsstrahlung spectra from x-ray machines. Unfortunately, the energy spectrum of emitted photons changes the moment they enter solid matter like tissue. Furthermore, the energy spectrum of scattered radiation differs considerably from that of the primary beam. For dose measurements in experiments requiring good accuracy it is necessary to know not only the energy range over which an instrument is energy-independent, but also the exact conditions under which the comparison against a standard was carried out. (auth)

15569 THERMOLUMINESCENCE OF LiF TLD-100 AT TEMPERATURES ABOVE THAT OF LIQUID NITROGEN AND EXTENSION OF ITS RANGE INTO THE MICRORAD REGION. Nollmann, C. E.; Smolko, E. E. (Comision Nacional de Energia Atomica, Buenos Aires). pp 143-154 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The thermoluminescent response of LiF TLD-100 to 200-kV x rays at temperatures from that of liquid nitrogen to 450°K was studied. With the equipment constructed it is possible to achieve linear heating rates; the detecting element is a photomultiplier (S20(Q)) with a trialkali cathode, low noise level and high sensitivity. The glow curves of virgin samples and of samples with a known thermal history were determined by varying the heating rates within the range 6 to 40°C/min and the radiation doses within the range 1 to 50 krad. In addition to the six known TLD-100 peaks, eight peaks were observed at temperatures below the ambient temperature. The activation energies of the electron-trapping levels and the characteristic parameters of each peak were calculated. The changes in the glow curves for the different samples were studied noting changes in the relative intensities of the peaks, the appearance of new peaks through the action of the ionizing radiation and the occurrence of clearly asymmetric shapes. In the case of the virgin samples two of the peaks appear only when high doses are administered, while other peaks do not appear in complete form. In the case of the samples with a known thermal history, inversion (compared with the case of the virgin samples) of the relative peak intensities was observed. The relative intensities of the peaks studied varied between 200 and 1, the most intense peak—at 127°K—being rather isolated and about 100 times more detectable than the usual dosimetric peaks. This characteristic should make it possible to extend the TLD-100 background measurement range into the microrad region. (auth)

15570 TLD PROBES FOR INTERCOMPARISON OF DOSIMETRIC DATA. Pohlit, W. (Gesellschaft fuer Strahlen- und Ulmweltforschung mbH, Frankfurt am Main). pp 155-164 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Thermoluminescent dosimeters can be used as very small probes for various dosimetric purposes. For intercomparison of dosimetric data of different institutions, the small volume and rigidity of the probes are their most important advantages as compared with gaseous or liquid dosimeter probes. On the other hand, the comparative uncertainty of calibration factors and fading effects offsets these advantages to a great extent. Solid LiF and CaF_2 probes linked with a suitable reader will give a measurement reproducibility of about 0.1%. The fading effects are large in LiF, due to the shallow traps in this crystal and to changes in the trap distribution (trap dynamics). Measurements of trap depth and of trap dynamics in CaF_2 have shown that this material could be used to obtain higher accuracy for such measurements. This has been proved under practical conditions. (auth)

15571 MIXED-FIELD DOSIMETRIC TECHNIQUES APPLIED TO MEDICINE AND BIOLOGY. Gommaa, M. A.; El-Naggar, A. M. (Atomic Energy Establishment, Cairo). pp 165-168 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The natural uranium fission fragment track dosimeter and the thermoluminescent dosimeter were tested for use in a mixed field of neutrons and gamma rays. Application of these dosimeters includes dosimetric response with human phantoms, and dose estimation in biological systems. (auth)

15572 THERMOLUMINESCENCE DOSIMETRY APPLIED TO AREAS WITH MIXED NEUTRON AND GAMMA RADIATION FIELDS. Majborn, B.; Boetter-Jensen, L. (Danish Atomic Energy Commission). pp 169-177 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The response of LiF and $Li_2B_4O_7$: Mn thermoluminescence dosimeters to thermal neutrons was investigated, primarily with a view to use them for personnel monitoring in areas with mixed neutron and gamma radiation fields. The investigations included: (1) measurement of TL response versus thermal neutron fluence, (2) measurement of TL response versus dosimeter thickness, (3) measurement of TL response versus isotopic abundance of ^6Li and ^{10}B, and (4) measurement of backscattering and γ-ray contribution from a phantom in a collimated-beam geometry. The results of the investigations can be summarized as follows: (1) LiF TLD-100 and $Li_2B_4O_7$:Mn can both be used in connection with LiF TLD-700 to determine the individual components of a mixed thermal neutron and γ-ray field. $Li_2B_4O_7$: Mn has a wider linear range than LiF TLD-100; (2) the thermal neutron responses of LiF TLD-100 and of $Li_2B_4O_7$: Mn are strongly dependent on dosimeter thickness owing to the significant self-shielding occurring in both phosphors; (3) the thermal-neutron/γ-ray response ratio can be varied over a wide range in LiF and $Li_2B_4O_7$: Mn by adjusting the $^6Li/^7Li$ and $^{10}B/^{11}B$ ratios; and (4) for a collimated thermal-neutron beam of a diameter of 7 cm incident on the front of a phantom, the thermal-neutron albedo is about 0.6 and the neutron-produced γ-ray dose at the phantom surface is about 3.5 rad per 4.2×10^{10} n/cm^2 incident on the phantom. (auth)

15573 SOME TSEE MEASUREMENTS OF DOSE GRADIENTS AT INTERFACES. Ennow, K. (National Health Service of Denmark). pp 179-186 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Interface dosimetry is a subject of great importance in many applications of ionizing radiation, for example, in biology and industry. It was expected that exoelectron dosimeters would have great advantages for measurements of dose distributions at interfaces because of their high sensitivity to low energy radiation and their small volume. Measurements were carried out with LiF/C TSEE dosimeters at interfaces between metal foils and Perspex, and the results are presented. The geometry and the radiation conditions were chosen in order to make possible comparisons with existing measurements performed using thermoluminescence dosimetry (TLD). (auth)

15574 OPTIMIZATION OF THE METHOD OF OBTAINING MANGANESE-ACTIVATED LITHIUM BORATE FOR USE IN THERMOLUMINESCENCE DOSIMETRY. Archundia, C.; Moreno, A.; Navarrete, M.; Alva, S. (Instituto Nacional de Energia Nuclear, Mexico City). pp 187-198 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Spanish)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The optimum method, selected from 28 procedures studied in laboratories, of obtaining manganese-activated lithium borate for use in thermoluminescence dosimetry is described. Experimental results relating to the thermoluminescent spectra obtained by irradiation with 40-kV x-rays (20 mA) and ^{60}Co gamma rays, to the half-life of the low- and high-temperature spectrum components, and to the linear behavior of the manganese-activated lithium borate for the kinds of radiation mentioned are presented. (auth)

15575 DETERMINATION OF OPTIMUM CONDITIONS FOR PHOTON COUNTING IN THERMOLUMINESCENCE MEASUREMENTS. Niewiadomski, T. (Inst. of Nuclear Physics, Krakow). pp 199-205 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Integration of PM tube pulse rates is a commonly used method of determining light output in thermoluminescence measurements. The possibility of increasing the sensitivity by means of TL photon counting has been recently reported, but a careful discrimination of TL signal pulses and background pulses has to be assured. In order to choose the most suitable PM tube and to define the optimum working conditions, the amplitude spectra of dark current and of other background components of several PM tubes were experimentally analyzed. Diagrams illustrating the dependences of the amplitude spectra on anode voltage, amplification factor, pulse forming and photocathode temperature, as well as some ways of improving the signal to background ratio are given. Generally the background components were suppressed as follows: (a) chemiluminescence by means of nitrogen flushing; (b) infrared radiation with an optical filter and limiting of maximum heating temperature; and (c) dark current by using the optimum PM tube voltage and appropriate pulse amplitude discrimination. Applying all these means and taking the TL response to a dose of 1 mrad as 1, the proportions of the components 1 : (a) : (b) : (c) were 1 : 0.2 : 0.01 : 0.1 for the best PM tube. Comparatively high pulse numbers per millirad cause the statistical error to be low, even at low doses. The PM tubes investigated exhibit a background equivalent to a dose about ten times lower than in the integrating method. Measuring the TL response of sintered LiF discs and LiF TLD-100 high sensitivity ribbons, doses of 0.2 mrad with a reproducibility of 20% and 0.5 mrad with a reproducibility of 30% SD respectively have been routinely measured. It should be stressed that the photon counting technique requires a highly stable apparatus which is able to amplify, discriminate and count the very narrow pulses at a high count rate. Photon counting appears to be specially useful for low dose measurements, because the very high pulse rate emitted by doses higher than 1 rad would impede counting unless complicated range switching was included. (auth)

15576 BERYLLIUM OXIDE THERMOLUMINESCENCE APPLIED TO RADIATION DOSIMETRY. Scarpa, G.; Benincasa, G.; Ceravolo, L. (CNEN, Rome). pp 207-214 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The present data are based upon a large number of experiments carried out on commercial sintered BeO, Thermalox 995. The main goal of the studies was to check a possible use of this material for dosimetry in conventional gamma and x-ray fields and in mixed fields of neutrons and gamma rays. Among the results, it was found that: (1) the annealing parameters were 600°C for 5 min. The annealing can be omitted following irradiations below 1 R, without large changes in precision; (2) the linear correspondence range of BeO ends at about 100 R for ^{60}Co γ-rays; (3) the standard deviation of repeated readouts performed on the same sample is between 1% and 2%, for doses ranging from 1 to 10^5 R. Below 1 R it increases rather sharply, reaching 20 to 30% at 50 mR. This rise is mainly due to spurious readouts, recorded in about 7% of the total number of low-dose measurements; (4) as far as the energy response is concerned, a top value of 1.25 (compared to ^{60}Co γ-rays) is reached at about 100 keV. The curve approaches unity for effective energies around 30–40 keV; (5) fading in the dark is not very significant, being about 8% after 2 months; and (6) an ultraviolet exposure of the sample, after the normal readout, makes a second reading possible, though with a lower efficiency and a higher standard deviation. (auth)

15577 RADIOTHERMOLUMINESCENCE OF Mn-ACTIVATED METAPHOSPHATE GLASS AND ITS APPLICATION TO LOW- AND HIGH-LEVEL PHOTON DOSIMETRY. Regulla, D. F. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Nuremberg). pp 215-227 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Despite the great variety of integrating solid-state dosimetry systems, there is a lack of one providing a wide detection range and homogeneous sensitivity between individual detectors. The present investigations on metaphosphate glass doped with manganese suggest one way of overcoming these problems. This glass is also used as a photoluminescent reference light source in phosphate glass dosimetry, as it does not show radiophotoluminescence and discoloration after moderate exposure to ionizing radiation; however, it emits intensive radiothermoluminescence. The thermoluminescence output turned out to increase with exposure between 10 mR and 1 MR. The manganese activator provides a lower energy dependence as compared with silver in radiophotoluminescent phosphate glass. For these reasons, the new detector material seems to be of interest for a great variety of dosimetric applications, including high-level dosimetry in agriculture and industry. Physical properties of the new detector, i.e., optical density, glow spectra, spectral distribution of photoluminescence

and radiothermoluminescence, are discussed. Dosimetric properties reported are sensitivity, detection limits, energy dependence and reproducibility. The results are compared with data known from silver-activated phosphate glass. (auth)

15578 DEVELOPMENT OF LiF SINGLE CRYSTALS FOR IN VIVO RADIATION DOSIMETRY. Sachdev, M. R.; Hukkoo, R. K.; Somasundaram, S.; Wadhwani, C. N. (Bhabha Atomic Research Centre, Trombay, India). pp 229-242 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The thermoluminescent phosphor LiF has been widely used for mapping radiation fields and for estimating radiation exposures. However, its toxicity restricts its use in bare form as an in vivo dosimeter. In addition, etching of the crystal surfaces by, for example, body fluids releases the stored energy and results in a change of transparency to its own thermally-stimulated emission. This requires a fresh set of calibration curves which can only be obtained after retrieval of the dosimeter. A technique has been developed to give a protective coating of SnO_2 to bare LiF single crystals to overcome some of these difficulties. The stability of the film has been studied by subjecting the dosimeters to numerous standard annealing, irradiation and read-out cycles. The film is found insoluble in solutions of different pH-values, comparable to those of body fluids. Preliminary data on mice show that the treated dosimeters are very well accepted by living tissue. Various characteristics of bare and coated dosimeters are discussed. (auth)

15579 NEW MATERIAL FOR EXOELECTRON DOSIMETRY. Brunsmann, U.; Euler, M.; Kriegseis, W.; Scharmann, A. (Univ., Giessen, Ger.). pp 255-264 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The thermally stimulated exoelectron emission of BeO is greatly affected by addition of other oxides. ZnO causes an improvement of the sensitivity. This makes BeO/ZnO a favorable detector material for TSEE dosimetry. Dosimeters have been prepared from heat treated powder mixtures of either BeO and ZnO, BeO and ZnS, or $BeSO_4$ and $ZnSO_4$. In all cases the resulting products were the same, because in air $BeSO_4$ is converted to BeO, and ZnS and $ZnSO_4$ to ZnO at high temperatures. Various mixing ratios and the relation between sensitivity and length of the heat treatment have been studied. Fading characteristics and dose response of BeO/ZnO dosimeters are compared to those of BeO containing no ZnO. (auth)

15580 APPLICATION OF THERMOLUMINESCENCE METHODS TO BONE DOSIMETRY. Spiers, F. W.; Beddoe, A. H.; King, S. D.; Whitwell, J. R. (Univ. of Leeds, Eng.). pp 265-275 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The thermoluminescence of fine-grain LiF powder is used to determine the absorbed dose rate to bone marrow in trabecular bone of a beagle reared on a diet containing ^{90}Sr. The production and properties of the LiF powder are described and particular attention is given to the preparation and filling of the sections of trabecular bone, so that the linear β-particle stopping power of the powder in the cavities is equivalent to that in bone marrow. Calibration of the LiF thermoluminescence has been made by the use of ^{60}Co γ-rays and plaques of bone-like material containing known activities of ^{90}Sr. Factors are given which enable the absorbed dose rates in bone marrow to be derived from the measurements in LiF and absorbed dose rates are given for marrow in the proximal ends of the humerus and femur. Some preliminary comparisons are made with dose rates expected on theoretical grounds. (auth)

15581 TLD APPLIED TO NEUTRON DOSIMETRY. Blum, E.; Bewley, K. D.; Heather, J. D. (Hammersmith Hospital, London). pp 277-290 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Calcium fluoride(Mn)-Teflon TLD has been used for dosimetric studies of the fast neutron beam from the MRC Cyclotron. The very small intrinsic sensitivity of this phosphor to fast neutrons makes it suitable for investigating the gamma contribution in the field. The percentage of dose due to γ-rays was found to be 5%, in reasonable agreement with a measurement of 3% using photographic film. Exposures in pairs, one in an hydrogenous surround (polyethylene), the other in lead, enable the gamma and neutron components to be measured separately. This method has been applied in depth dose studies in tissue-equivalent phantoms. The dosimeters were discs of 6 mm dia. × 0.13 mm and the read-out instrument used was a Conrad model 5100. Reproducibility of 3% has been obtained using a controlled calibration and annealing technique. The angular response severely limits its application in clinical use. Preliminary evaluation of calcium sulphate(Tm) powder phosphor in neutron dosimetry is described. Mixing the powder with glucose as a hydrogenous compound provides a dosimeter with practically no directional dependence; this makes the dosimeter suited for use in neutron therapy. An evaluation of calcium sulfate(Dy) was also made with a view to dosimetry in environmental studies. (auth)

15582 DOSIMETRY BASED ON MAGNETIC RESONANCE SPECTRA. Manambelona, J. R. (Laboratoire de Radioisotopes, Tananarive, Madagascar). pp 293-301 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In MS)

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The contemporary nuclear techniques based on exploitation of resonance phenomena can be utilized in dosimetry. The basic principles of paramagnetic electron resonance and nuclear magnetic resonance are presented, the techniques are briefly described. An indication of the specific problems such as instrumental sensitivity, irradiation techniques and chemical methods is given. It is shown that the resonance techniques are a powerful tool for identification of irradiation products. The quantitative analysis of data obtained with these techniques will need further development. It is a conclusion of the present work that in a multidisciplinary approach to the more complex problems in dosimetry the resonance techniques could play an important part. (auth)

15583 HIGH GAMMA-RAY DOSE MEASUREMENT BY MEANS OF MOESSBAUER SPECTROSCOPY. Takashima, Y. (Kyushu Univ., Japan); Nakayama, Y.; Chandler, L. pp 303-310 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The applicability of Moessbauer spectroscopy for high γ-ray dose determination was explored by examining a number of iron compounds for radiation-induced changes in their spectra. It was found that iron(II) sulfate heptahydrate is useful in the 10^8 to 10^{10} rads range while anthracene-$FeCl_2$ or perylene-$FeCl_2$ molecular compounds respond in the 10^7 to 10^8 rads range. With this method the fraction of radiation-induced chemical species to the total species was correlated with the dosage received. The percentage of the fraction was determined in a fairly automatic way by computer analysis of the Moessbauer spectra. We believe that this new dosimetric method is very useful for high γ-ray dose measurement because of its reproducibility and stability. (auth)

15584 CALORIMETER FOR ABSOLUTE CALIBRATION OF THIN-FILM DOSIMETERS IN ELECTRON BEAMS. Radak, B. B.; Hjortenberg, P. E.; Holm, N. W. (Danish Atomic Energy Commission, Roskilde). pp 311-318 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

A quasi-adiabatic differential calorimeter based on the total absorption of a sector of a low-energy electron beam is described. The calorimeter comprises two separate thermally-insulated bodies set up under identical experimental conditions. One of the bodies, shaped as a Faraday cup, is exposed to the electron beam, while the other serves as reference. As the system is used for short exposures only, no temperature control of the jacket is necessary. Consistent results were obtained from the electron beam of a 400 keV constant-current insulated-core-transformer accelerator. Measurements were performed over an energy input range of 0.08 to 0.60W with an accuracy better than ±5%. The calorimeter was also used for calibration of thin-film dosimeters stacked in a rig of the same shape as the calorimeter body. (auth)

15585 COMPUTER DOSIMETRY FOR RADIATION THERAPY. Levan, J. H.; Prasad, S. G.; Stefani, S.; Sherwood, G. (Veterans Administration Hospital, Hines, IL). pp 341-348 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The application of computers in radiation therapy has advanced rapidly during the past few years, especially in the field of treatment planning. A number of small computer systems have been developed to display isodose distributions derived from multiple external beams. Recently, we have extended the use of the computer to the routine calibration of therapy equipment. Normally, calibration of therapy machines requires a great deal of manual effort, from table-searching to interpolation and calculations. With a number of programs written specifically for calibration purposes this time-consuming procedure can be eliminated. Readings on only one single field size are required. This information, along with other physical factors such as temperature, pressure and backscattering are then entered into the computer and from this, the exposures and dose-rates for any other field sizes (of either rectangular or circular shapes) are printed out. This method has been found very useful for calibrating orthovoltage machines for HVL ranging from 0.5 to 4.0 mm Cu, with a precision exceeding data previously published using other techniques. We are in the process of expanding this application to high-energy therapy equipment such as cobalt-60, betatrons, and linear accelerators. Long-distance calibration services are also being carried out using LiF dosimeters exposed to radiation beams in participating institutions and mailed to us for analysis by the thermoluminescent technique. Computer printouts can be returned by mail or via telecopier. The implications of this dosimetry method are particularly useful for developing countries, especially those using the services of regional standard laboratories. No elaborate calibrating equipment is needed at field installations and the service of expert physicists for this purpose is not necessary. (auth)

15586 CURRENT TENDENCIES IN CHEMICAL DOSIMETRY. Draganic, I. G. (Boris Kidric Inst. of Nuclear Science, Belgrade); Gupta, B. L. pp 351-366 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From Symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The present status and current tendencies in chemical dosimetry of the kilorad-to-megarad dose range are summarized. It also includes some low dose level liquid chemical dosimeters used for the rad range. Present limitations of and probable future trends in chemical dosimetry are considered. Basic problems in developing a chemical dosimeter seem to be understanding and controlling the reaction mechanism proposed as the measure of dose. (auth)

15587 ROUTINE DOSIMETRY FOR HIGH-ACTIVITY GAMMA IRRADIATION FACILITIES. Foeldiak, G.; Horvath, Z.; Stenger, V. (Inst. of Isotopes, Budapest). pp 367-381 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The 80,000 Ci activity ^{60}Co irradiation facility of the Institute of Isotopes is used not only for research purposes but also for pilot-plant work. A physical dosimetry method employing p-n silicon diode detectors operated in short-circuit current mode has been found suitable for rapid measurement of β- and γ-radiation. For systematic checking of, for example, sterilizing doses, chemical dosimetric methods less sensitive to contamination than the conventional aqueous systems are desirable. For such purposes oscillometric chlorobenzene dosimetry in closed glass or plastic ampoules is feasible. Since in these circumstances the conductivity doses do not in practice alter for at least two years after irradiation, the procedure is well suited for ensuring that irradiation processes meet health authority regulations for sterilization of medical instruments. Computer programs have been worked out which, from a knowledge of the geometry and the activity of each element of the source, can calculate the values of the relative dose rate in the irradiation chamber. Establishment of absolute doses requires direct dosimetric measurements. (auth)

15588 ELECTROCHEMICAL DOSIMETRY USING FERRIC-FLUORIDE ION COMPLEX FORMATION. McLaughlin, W. L.; Bjergbakke, E. (Danish Atomic Energy Commission, Roskilde). pp 383-396 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Irradiated aqueous ferrous sulfate solutions containing fluoride ions can be analyzed for ferric ion yield by means of electrochemical potentiometry. For certain applications this approach has advantages over the usual method of spectrophotometric determination of ferric ion concentration, which also varies linearly with absorbed dose up to about 40 krad, e.g., (1) small dosimeter volumes down to 10 microlitres are functional; (2) solid gels may be used, thus allowing for thin-film geometries; and (3) the potentiometric method permits real-time (current readings) or integrated (EMF readings) measurement of radiation dose. The electrochemical analysis of ion-complex yield is fairly simple. A fluoride ion electrode of the solid-state type serves as an ion-selective sensor. The electrochemical potential (or its rate of change in some instances) between the fluoride ion electrode and the reference electrode is then read on a pH-meter. Since the Fe^{3+} cation complex with F^- is not passed by the lanthanum fluoride crystal membrane at the end of the electrode probe, and since the free F^- ion concentration diminishes linearly with dose up to about 40 krad (correspondent to approximately 0.4 mM Fe^{3+} ion concentration at pH 2.7), the dose or dose rate can be determined from readings of linear change in millivoltage or rate of change of millivoltage. For cobalt-60 gamma-ray irradiation of a 1.00 mM solution of Fe^{2+} and F^- made to pH 2.7 with H_2SO_4, the G-value of $Fe^{3+}-F^-$ complex formation is 13.7 ± 0.3 per 100 eV energy absorbed. This G-value is in good agreement with the initial G-value 13.75 of the Fricke dosimeter at pH 2.74. (auth)

15589 REACTION MECHANISM OF THE FERROUS SULFATE DOSIMETER AT HIGH DOSE RATES. Sehested, K.; Bjerbakke, E. (Danish Atomic Energy Commission, Roskilde). pp 397-404 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The yield of the Fricke dosimeter, G[Fe(III)], and $G(H_2)$ was measured at dose rates up to 64 krad/1.4 μs pulse in the air-saturated 1 mM $FeSO_4$ dosimeter, and G[Fe(III)] was measured in the O_2-saturated 10 mM $FeSO_4$ dosimeter, each in 0.4 M H_2SO_4. G[Fe(III)] decreases in both dosimeter systems less rapidly with increasing dose rate than found by earlier workers. Based on homogeneous kinetics, the results are interpreted by a system of 18 chemical reactions. The principal reason for the decrease is the failure of the O_2 to scavenge the hydrogen atoms at high dose rates. Excellent agreement is obtained between experiment and theory, but at high dose rates the calculated values of G[Fe(III)] are slightly too high in both dosimeter systems. (auth)

15590 APPLICATION OF THE ETHANOL-CHLOROBENZENE DOSIMETER TO ELECTRON-BEAM AND GAMMA-RADIATION DOSIMETRY. II. Cobalt-60 Gamma Rays. Razem, D.; Dvornik, I. (Ruder Boskovic Inst., Zagreb). pp 405-419 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

An investigation on the application of the ethanol-chlorobenzene dosimeter to the dosimetry of cobalt-60 gamma radiation is reported. Radiation chemical yields of HCl, represented by $G(Cl^-)$ for systems containing from 4 to 40 vol. % chlorobenzene, are given as a function of some variables of importance in dosimetric practice, e.g., dose, dose rate and oxygen content. From these data the dose ranges and relevant $G(Cl^-)$-values required for a practical use of the dosimetric system are derived under various conditions, ranging from vacuum sealed samples to those in equilibrium with oxygen. In no case did the dose exceed 20 Mrad. The results are discussed in terms of the criteria required of a chemical dosimetric system. Some aspects of the mechanism yielding HCl are discussed. (auth)

15591 LOW-LEVEL DOSIMETRIC STUDIES WITH THE $FeSO_4$–BENZOIC ACID-XYLENOL ORANGE SYSTEM. Gupta, B. L. (Directorate of Radiation Protection, Trombay, India). pp 421-432 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The radiation chemistry of a system containing ferrous sulfate, xylenol orange and benzoic acid in 0.05 N sulfuric acid has been studied. In this system the benzoic acid increases the yield of ferrous ion oxidation. The ferric ions so produced form a com-

plex with xylenol orange having a maximum absorption at 540 nm in 0.05 N sulfuric acid. The effect of ferrous ion, xylenol orange and benzoic acid concentrations on the radiolytic formation of the complex has been studied. On the basis of these studies, a dosimetric solution containing 0.20 mM ferrous ions, 0.05 mM ferric ions, 0.20 mM xylenol orange and 5.0 mM benzoic acid in 0.05 N sulfuric acid has been found to be suitable for measuring radiation doses as low as one rad. This system was found to be energy independent above x-ray energies of 33 keV and could span a dose range of 1 to 3000 rads. It was further observed that this system is not sensitive to pre-irradiation storage for periods ranging up to six months. (auth)

15592 SUITABILITY OF B. SPHAERICUS STRAIN C_1A AS A BIOLOGICAL EFFECTS DOSIMETER. Emborg, C.; Eriksen, W. H.; Holm, N. W. (Danish Atomic Energy Commission, Roskilde). pp 433-439 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

A number of microbiological test piece systems have been used for testing the efficiency of sterilization procedures. B. sphaericus, strain C_1A, is presently being used as spore monitor for efficiency testing of radiation sterilization plants. The test piece system is intended as an integrated check on the sterilization process, i.e., the adequacy of the process under the given conditions, including packaging, state and kind of products, environmental conditions, and irradiation conditions (radiation spectrum, dose rate, dose, etc.). Experience has shown that the inactivating effect on B. sphaericus of a given absorbed dose is quite independent of environmental and irradiation conditions, and it is suggested that the system be considered as an "effects dosimeter", for example, in biological research. Preparation techniques, dose response and some results of practical testing are described. The precision is of the order of ±5% and the useful absorbed dose range in 1 to 5 Mrad. (auth)

15593 DOSIMETRY FOR RADIOBIOLOGICAL STUDIES USING HIGH ENERGY PARTICLE BEAMS. Sullivan, A. H.; Baarli, J. (CERN, Geneva). pp 441-450 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The methods used to estimate the absorbed dose to biological objects irradiated in high energy neutron, proton and pion beams are described. The limitations of tissue-equivalent ionization chambers when used for high energy particle dosimetry are discussed and an estimation of the correction required is given. Depth-dose curves are presented and dosimetry problems associated with the spatial distribution of the dose are considered. It is concluded that absorbed dose to a biological object in a high energy particle beam can be estimated to within about 10%. (auth)

15594 CHARACTERISTICS OF IONIZATION CHAMBERS FOR FAST NEUTRON DOSIMETRY AND THEIR CALIBRATION. Kuehn, H. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Frankfurt am Main). pp 453-462 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

For the determination of fast neutron dose in mixed fields two types of cylindrical ionization chambers, one type with tissue-equivalent wall material and one with graphite wall material, are described. A digitized current integrator is used, with the possibility of preselection of charge values. The chambers have been calibrated with x rays or γ-rays using an extrapolation chamber, and the calculated results for the neutron sensitivity have been compared with activation methods for 14-MeV neutrons. The calibration and the errors in measuring the total dose for both neutron and gamma doses are discussed. The saturation behavior of the chambers was taken into consideration for different neutron dose rates. The attenuation of the chamber walls as it affects dose values has been studied. The influence of the gas pressure for tissue-equivalent and CO_2 gas fillings is given. (auth)

15595 IONIZATION CHAMBERS, FREE OF POLARITY EFFECTS, INTENDED FOR ELECTRON DOSIMETRY. Markus, B. (Univ., Gottingen, Ger.). pp 463-473 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Two parallel plate chambers (phantom and extrapolation types) were constructed to serve for electron dosimetry. They are freed of a polarity effect by use of a principle not previously used (diminished collector volume). Comparative measurements with a conventional commercial phantom-type x-ray chamber are reported. The origin and behavior of the polarity effect is discussed and is demonstrated for 5- and 15-MeV electrons. (auth)

15596 DEVICE WITH PRECISELY DEFINED THERMAL NEUTRON FLUX FOR DOSIMETER CALIBRATION. Dryak, P. (Inst. for Research, Application, and Production of Radioisotopes, Prague); Shela, I. pp 475-480 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The measurement of absorbed doses in a neutron field and in a mixed neutron-gamma field was studied. In order to investigate the energy dependence of neutron dosimeters one needs, among other things, data on the behavior of the dosimeters in a thermal neutron flux. A device which produces a precisely defined thermal neutron flux has been proposed and built with a view to carrying out the necessary calibrations. Its operation is based on the slowing-down of fast neutrons from an Am–Be source by paraffin wax. Using a 3 Ci source one obtains a flux density of about 3×10^3 neutrons/cm^2 · sec. The principal condition for using the device is that one should know its parameters, the most important of which is the density of the thermal neutron flux. The activation method was used for measuring this, and, as the method has reached a fairly high degree of perfection, no difficulties are encountered. The method of measuring the exposure dose rate for gamma radiation in a neutron field has not been perfected to the same extent and considerable time is being devoted to this problem, as the parameter in question is an indispensable one. Two methods were used for the measurements, the results being in good agreement. The construction of this device, which fully meets the need for a source producing a constant, precisely defined thermal neutron flux, has eliminated a major deficiency in the field of neutron dosimeter calibration in the Czechoslovak Socialist Republic. (auth)

15597 THEORETICAL CORRECTIONS NECESSARY FOR INTERPRETING MEASUREMENTS MADE WITH A CAVITY CHAMBER: USE IN DETERMINING THE ABSORBED DOSE IN AIR. Simoen, J. P.; Pages, L. (CEN, Saclay, France). pp 481-495 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Whatever the photon energy, the use of cavity chambers in photon dosimetry raises the dual problem of the structural materials to be used and the dimensions of the two basic elements of the chamber—the wall and the cavity. The influence of these latter, which is obviously a function of the incident photon energy, must be known in order to permit the geometry and the structural materials to be chosen before the chamber is built and, once this choice has been made, to permit the necessary corrections to be made when the chamber is being used. From the theoretical point of view, the problem is simply one of expressing the dose $D_M(x_M)$ absorbed in a medium M at a given depth x_M in terms of the dose measured in the cavity of a chamber, taking into account the structural materials, the wall geometry and the size of the cavity. This problem can be resolved on the basis of three factors, which are defined: the factor for achieving chamber equivalence, for a medium M, to a plane chamber with an ideal cavity; the cavity correction factor, which expresses the influence of the nature and dimensions of the cavity; and the wall curvature correction factor. Numerical values of these three factors are calculated for photon energies between 10 keV and several MeV for the typical case where the reference medium M is air and for a cylindro-spherical chamber with an air-filled cavity (5 cm^3) and walls of carbon, aluminium, copper or a Teflon-carbon mixture. The calculated values are verified experimentally for a number of photon energies. This work was done as part of a program for building a reference cavity chamber. (auth)

15598 EXTENDING THE USE OF IONIZATION CHAMBERS IN DOSIMETRY WITH THE AID OF THEIR UNIVERSAL (VOLT-AMPERE) CHARACTERISTICS. Archev, I. A.; Ivanov, V. I. (Inst. of Engineering Physics, Moscow). pp 507-514 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The use of ionization chambers in dosimetric systems depends on the maintenance of saturation conditions. None of the existing approximate solutions of ionization chamber equations is suitable for describing the volt-ampere characteristic over a wide range of dose rates and electric field strengths. Consequently, while approximate analytical solutions are useful in the design of ionization chambers, they are not very suitable for finding the saturation current when the chamber is being used. The authors obtain theoretical and experimental confirmation of a volt-ampere characteristic which is universal for chambers of a given shape, i.e., which does not depend on the chamber dimensions or on the dose rate. Universal characteristics are presented for plane-parallel and cylindrical chambers and their practical usefulness is discussed. Universal characteristics extend the range of applications of ionization chambers as dosimetric detectors, especially in strong radiation fields. (auth)

15599 DETECTORS FOR MEASURING EXPOSURE DOSE RATES IN THE RANGE 10^{-3} TO 10^{6} R/SEC. Muchachev, B. V.; Rudakova, G. M.; Samoilor, P. S. (All-Union Research Inst. for Instrument Making, Moscow). pp 515-525 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Two types of detectors resistant to thermal radiation have been developed for monitoring and exposure dose rate measurement in industrial facilities which produce intense gamma radiation fields: ionization chambers and "vacuum radiation elements" ("gamma elements"). The special design features and the main characteristics of these detectors are described. The operating range of the ionization chambers is 10^{-3} to 10^{4} R/sec, their sensitivity about 10^{-9} A/(R/sec), their ion collection efficiency for the maximum dose rate at least 98% and their maximum operating temperature 100°C. The operating range of the "gamma elements" is 10^{3} to 10^{6} R/sec, their maximum sensitivity 10^{-12} to 10^{-13} A/(R/sec) and their maximum operating temperature 400°C. Measurements of exposure dose rates in intense gamma radiation fields performed with these detectors have yielded results which are in good agreement with those obtained by other methods. Examples are given of how the detectors can be used for investigating the gamma radiation fields in gamma-emitting isotope facilities and in reactor channels. (auth)

15600 EXTRAPOLATION CHAMBER FOR MEASUREMENT OF BETA-RAY SOURCES. Jableonska, J.; Kuchta, M. (Inst. of Nuclear Research, Swierk, Poland). pp 527-532 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

An extrapolation chamber is described which is used for measurements of surface dose rate of beta sources. The results of measurements for ^{204}Tl source are given, and the method of calculation is presented together with the accuracy obtained. The maximum total error is 5%. (auth)

15601 TRACK STRUCTURE THEORY IN DOSIMETRY. Katz, R. (Hammersmith Hospital, London). pp 535-553 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The δ-ray theory of track structure, evolved over the past decade, attributes the response of a variety of detectors to energetic heavy ions to the secondary electrons (δ-rays) ejected into the medium during their passage. The theory has been applied to a variety of detectors of interest in dosimetry, including nuclear emulsion, scintillation counters, plastic, glass, thermoluminescent, and chemical dosimeters, enzymes, viruses, and biological cells. It is applicable to a mixed radiation environment, including stopping particles, as well as to track segment bombardment. The theory attempts to relate the response of a detector to γ-ray irradiation to its response to energetic heavy ions. It is therefore directed to the understanding of what are called LET effects, or isotope effects in detection and dosimetry. (auth)

15602 DOSIMETRY BASED ON OPTICAL EFFECTS RESULTING FROM IRRADIATION OF SOLIDS. Nicolae, M. (Inst. of Atomic Physics, Bucharest). pp 555-561 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The behavior of metaphosphate glasses and of some plastics was investigated with the aim of developing dosimetric systems based on optical absorption measurements on solids irradiated with γ-rays and fast neutrons. It was found that the radiophotoluminescent metaphosphate glasses could be useful in dosimetry in a range of doses from 10^{3} to 10^{5} rad for which the optical absorption variation in the uv region (300 to 400 nm) is a linear function of dose. Fading under the measuring conditions was negligible. While cellulose acetate was more sensitive than nitrate, both materials proved to be less sensitive to γ-rays than the glasses. However, the use of plastics could be of interest for fast neutron dosimetry. (auth)

15603 CHOICE OF MEASUREMENT WAVELENGTH FOR CLEAR HX PERSPEX DOSIMETRY. Chadwick, K. H. (EURATOM-ITAL, Wageningen, Netherlands). pp 563-568 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The effects of storage time, storage temperature, and irradiation time and temperature on the radiation induced optical density spectrum in clear HX-dosimetry Perspex are considered. It is shown that measurements at 305 nm, the currently accepted wavelength, are affected by these factors and are consequently not reliable. It is also shown that in a small wavelength region these factors have a minimal effect and a proposal is made to change the measurement from 305 nm to a wavelength in this region. (auth)

15604 MECHANISM INVOLVED IN THE EFFECT OF TEMPERATURE AND LIGHT ON THE CLEAR PERSPEX DOSIMETER. Chadwick, K. H. (Euratom-ITAL, Wageningen, Netherlands); Ten Bosch, J. J.; Verhelst, W. F. pp 569-576 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The mechanism causing optical density (OD) changes in the clear Perspex dosimeter, following heat treatment and exposure to light, is discussed. The mechanism is shown to be caused by a radical conversion process and the effects of this process on the OD and ESR spectra are presented. The radicals are not identified but a schematic diagram for the process is given. The relevance of these effects to the use of clear Perspex in dosimetry is considered. (auth)

15605 ABSORBED DOSE MEASUREMENTS WITH THIN FILMS. McLaughin, W. L.; Hjortenberg, P. E.; Radak, B. B. (Danish Atomic Energy Commission, Roskilde). pp 577-597 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Thin films of plastic, coatings, papers, ceramics, emulsions, cleaved crystals, microtomed gel sections, and metal foils have all been used with advantage to measure large radiation absorbed doses. The three most successful methods of relating the radiation effects in the film to the dose are: Calorimetry, which measures temperature rise; photometry, which measures changes in light emission, transmission or reflection; and electrometry, which measures electrical changes, such as variations in resistivity, emf, current, etc. The chief problems in making good measurements of radiation dose or dose rate with thin films are: (1) quality control of the dosimeter itself; (2) discontinuity problems, that is, how the energy imparted to a thin probe is related to energy imparted to surrounding matter; and (3) meaning of the calibration, that is, how the radiation effect in the film material is related to the absorbed energy as a function of spectrum, dose rate, temperature, etc. The first of these can be dealt with effectively by control of film thickness, chemical composition and environmental influences. The second is often more complicated, especially if the thin probe differs appreciably in absolute density and atomic number from its surroundings, since proper application of cavity theory may be difficult for some geometrical arrangements. The third problem is usually the most difficult of all, because the radiation effect in a thin material used as a dosimeter often depends on many variables leading to systematic errors in dose interpretations. In this work, methods are given for calibrating in electron beams the radiation response of thin-film dosimeters calorimetrically, accounting for the sources of error cited above. The calibration pro-

cedures include the use of appropriate cavity-theory correction factors needed to relate the response of the thin probe of one material held in another medium. Finally, a suitable film dosimeter material is described. It consists of radiochromic dye films, which can measure doses from about 10^4 to 10^8 rad in various media under different irradiation conditions. (77 references) (auth)

15606 PLASTIC FILM DOSIMETERS. Broszkiewicz, R. K.; Bulehak, Z. (Inst. of Nuclear Research, Warsaw). pp 599-606 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

A comparison of polyvinyl chloride, polymethacrylic and polyester films used as gamma-ray dosimeters is given. Their value as routine radiation source dosimeters, and the dependence on the make and the physical data of the particular film, is discussed. Recommended procedures for processing and reading out the films are presented. (auth)

15607 USE, IN RADIOBIOLOGICAL RESEARCH, OF NEW DOSIMETRY METHODS FOR DETERMINING THE CHARACTERISTICS OF RADIATION BEAMS ISSUING FROM REACTOR CHANNELS. Keirim-Markus, I. B. (Inst. of Biophysics, Moscow); Kraitor, S. N.; Popov, V. I.; Ivanov, V. N.; Ryabukhin, Yu. S.; Efirmov, N. A. pp 607-613 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The results obtained in measurements of the dosimetric characteristics of the BR-5 reactor channels used in radiobiological research are presented. Neutron spectra, LET spectra and absorbed doses were measured. The neutron spectra were measured using a set of fissioning isotopes in conjunction with track detectors; the LET spectra were measured with a set of tissue-equivalent low-efficiency Geiger counters; the absorbed doses were determined by means of both fissioning isotopes and chemical dosimeters. The measurement results are compared with existing computational and experimental data. (auth)

15608 ELECTRON DOSIMETRY USING CHALKLEY–McLAUGHLIN DYECYANIDE THIN FILMS. Eisen, H.; Rosenstein, M.; Silverman, J. (National Bureau of Standards, Gaithersburg, MD). pp 615-625 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The measurement of electron energy deposition profiles in a variety of absorbing materials and evaluation of the Chalkley–McLaughlin radiochromic dye-cyanide film dosimeter are described. Information of this type is useful for effective utilization of electron beams in industry and medicine where adjustments in sample thickness, electron beam energy, angle of electron beam incidence, and backing materials may provide more advantageous beam utilization. Experimental depth-dose distributions were determined for broad beams of 2.00-MeV electrons incident on polystyrene, aluminium, copper, tin, gold, and several two-layer slab absorbers. Data were obtained for both semi-infinite and finite homogeneous absorbers at incident beam angles ranging from 0 (normal incidence) to 75 degrees. Radiochromic dye-cyanide films were used as solid-state cavity dosimeters, with an experimental reproducibility of ±6% (2σ). The stopping power ratio necessary to convert from film dose to absorber dose was evaluated several ways. Depth-dependent stopping power ratios, obtained by accounting for the changing electron energy spectrum with absorber depth by two methods, were compared with a constant stopping power ratio for each material. The difference between the constant ratio and a depth-dependent ratio was 1% to 2% for aluminium, 3% to 5% for copper, 3% to 7% for tin, and 3% to 8% for gold. The data demonstrate the decrease in the depth-dose distribution and the total absorbed dose in finite slabs as compared to equivalent layers in semi-infinite slabs. The effect of the atomic number of the absorber and the angle of beam incidence on the shape of the energy deposition profile is also demonstrated. The data for the two-component slab absorbers illustrate the modification of the depth-dose profile in a finite slab of material if a different material is placed adjacent to it. From the dose received by a film placed at the interface, the surface doses at that position were estimated using the material-to-film stopping-power ratio appropriate for each material. The data are compared to theoretical depth-dose profiles obtained using Monte Carlo transport codes. The agreement is generally between 5% to 10% for homogeneous cases and in most cases better than 10% for the two-component cases. (auth)

15609 EMERGENCY NEUTRON TRACK DOSIMETER. Obaturov, G. M.; Rybanov, V. V.; Chumbarov, Yu. K.; Shalin, V. A. (Physical-Power Engineering Inst., Obninsk, USSR). pp 651-661 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The characteristics of an emergency neutron track dosimeter consisting of four detectors (^{237}Np, ^{238}U and natural uranium with and without a cadmium filter) in contact with mica or glass are described. The sensitivity of such detectors to flux and dose has been determined with a Po–Be source. The mean dose sensitivity of the track detectors to neutron fluxes with 12 different spectra is calculated and the results are presented. It appears from the calculations that the dose sensitivity of the Np-detector is independent of the shape of the spectrum to within ±10% for neutrons with $E_n \geq 0.45$ MeV and to within $\{^{+10\%}_{-50\%}$ for neutrons with 0.5 eV $\leq E_n \leq$ 10 MeV. With the other detectors the dose sensitivity is more dependent on the shape of the spectrum. Using this dosimeter one can measure the absorbed dose and dose equivalent of thermal neutrons in the ranges 2×10^{-4} to 70 rad and 2×10^{-3} to 700 rem, epithermal (0.5 eV $\leq E_n \leq$ 10 MeV) neutrons in the ranges 0.3×10^{-2} to 10^4 rad and 0.3×10^{-1} to 10^5 rem, and the fast ($E_n \geq 1.5$ MeV) neutrons in the ranges 0.2×10^{-1} to 5×10^3 rad and 0.2 to 5.5×10^4 rem. (auth)

15610 DOSIMETRIC CHARACTERISTICS OF DIRECT-CHARGE DETECTORS. Ivanov, V. I.; Kulakov, G. V.; Kozlov, O. V.; Salamakha, B. S.; Goncharov, A. S. (Inst. of Engineering Physics, Moscow). pp 663-670 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In Russian).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

Theoretical and experimental investigations of the dosimetric characteristics of direct-charge detectors (with an evacuated space between plane and cylindrical electrodes) in the hard γ region are described. In the theoretical part of the paper, the authors derive an expression for calculating dose sensitivity and analyse the implications of that expression—especially the influence of radius ratio, electrode combinations and materials, angle of incidence and energy of photons, measured dose, etc. Enlarging on earlier work, the authors present new data on the quantum efficiency of different materials and the dose sensitivity of plane and cylindrical detectors. The experimentally determined relations between dose sensitivity and various parameters relating to the radiation, materials and electrode configurations are in good agreement with calculated results and with the data of other authors. Experimental data on the quantum efficiency of different materials are presented, as is the electron spectrum distribution in the energy range up to a few keV. Finally, recommendations are given for building direct-charge detectors and using them in dosimetry. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 16398, 16970, 16993, and 17056.

15611 (ANCR-1113) GAUSS VI: A COMPUTER PROGRAM FOR THE AUTOMATIC BATCH ANALYSIS OF GAMMA-RAY SPECTRA FROM Ge(Li) SPECTROMETERS. Cline, J. E.; Putnam, M. H.; Helmer, R. G. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jun 1973. Contract AT(10-1)-1375. 100p. Dep. NTIS $5.45.

A description is given of a computer program, GAUSS VI, that has been written to analyze automatically batches of gamma-ray pulse-height spectra acquired with Ge(Li) spectrometers. The program contains features such as automatic peak location and fitting, determination of peak energies and intensities, nuclide identification, decay corrections to the intensities, and correlation of data obtained in successive counts of the same sample. Complete descriptions are given of the program options and the card and tape formats. (auth)

15612 (BMFT-FBK-73-2, pp 78-79) PREPARATION OF A Ge(Li) COMPTON SUMMATION SPECTROMETER. Eberth, J.; Medina-Valcarcel, E. Mar 1973. (In German).

15613 (BMFT-FBK-73-2, pp 83-84) RING COUNTER FOR MEASUREMENTS AT EXTREME BACKWARD ANGLES. Berg, G.; Eberth, J.; Schieck, H.; Schulte, K. Mar 1973. (In German).

15614 (BMFT-FBK-73-2, pp 99-104) ANALYSIS OF GAMMA SPECTRA. Dauk, J. Mar 1973. (In German).

15615 (ITEF-880) SHORT DESCRIPTION OF KINEMATIC VARIABLES BALANCE PROGRAM FOR MAGIK-6 SPECTROMETER. Vladimirskii, V. V.; Grishin, A. P.; Nikolaevskii, E. S.; Petrukhin, V. N. (Gosudarstvennyi Komitet Po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 8p. (In Russian). INIS.

The basis of the program for the MAGIK-6 spectrometer utilizes the method of least squares allowing for kinematic associations. Geometrical coupling is allowed for in an implicit form by the assignment of supplementary terms in a functional. (tr-auth)

15616 (ITEF-907) APPROXIMATE DETERMINATION OF THE APEX OF A FORK FOR THE MAGIK-6 SPECTROMETER. Nikolaevskii, E. S.; Petrukhin, V. N.; Shestopal, V. E. (Gosudarstvennyi Komitet Po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 4p. (In Russian). INIS.

The apex of a fork was found from the minimum taken from weighted errors of the distance between trajectories. One or two minima may be present, from which data were selected at not too great a distance. A balance was subsequently determined. (tr-auth)

15617 (UCRL-51401) INTERPOLATION IN EXCITATION ENERGY FOR TWO-DIMENSIONAL TABULAR DATA. Perkins, S. T.; Doyas, R. J. (California Univ., Livermore. Lawrence Livermore Lab). 7 Jun 1973. Contract W-7405-eng-48. 10p. Dep. NTIS $4.00.

Techniques are presented for interpolation between two-dimensional tabular arrays that describe either inelastic neutron scattering through resolved or unresolved levels, or discrete photon production spectra. (auth)

15618 (UUIP-804) TECHNIQUES FOR FAST EVALUATION OF Ge(Li)-DETECTOR GAMMA-RAY SPECTRA WITH SMALL COMPUTERS. Nyman, B. (Uppsala Univ. (Sweden). Inst. of Physics). Feb 1973. 18p. Dep. NTIS (U. S. Sales Only) $3.00.

A computationally simple technique for evaluating Ge(Li)-detector gamma-ray spectra is described. The energies, intensities and FWHM's of the peaks are determined on the basis of smoothened first and second derivatives, which eliminates the need for a special background subtraction. Results obtained with a computer program employing this technique are presented. (auth)

15619 (UUIP-818) DESIGN PRINCIPLES IN ELECTRON SPECTROSCOPY. Wannberg, B.; Gelius, U.; Siegbahn, K. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1973. 43p. Dep. NTIS (U. S. Sales Only) $4.25.

The factors which determine the resolution and sensitivity of electron spectrometers are discussed. Various types of instruments commonly used in electron spectroscopy for chemical analysis are reviewed, mainly from an electron-optical point of view. The influence of fringing fields and pre-retardation on resolution and sensitivity is considered. Three different schemes for monochromatizing the exciting x rays are compared. (auth)

15620 CONSTANT-ACCELERATION MOESSBAUER SPECTROMETER. Ok, H. N.; Lee, S. W.; Cho, Y. C. (Yonsei Univ., Seoul). New Phys. (S. Korea); 12: No. 4, 142-144(Dec 1972). (In Korean).

A constant-acceleration Moessbauer spectrometer has been constructed utilizing a drive mechanism consisting of a loudspeaker coupled to a linear velocity transducer. The analog output of the address scaler of a multichannel analyzer is used as the input signal. A photocell is used to start each new cycle from the same position after a certain delay-time, during which the drive finishes a rapid fly-back motion at the end of each spectrum sweep. (auth)

15621 ASSEMBLY, FOCUSING, AND CALIBRATION OF THE SPECTROGRAPH(IV) AND ITS USE IN THE SPECTROGRAPHIC INVESTIGATION OF ^{41}Ca AND ^{49}Ca BY (d,p) REACTIONS. Delgadillo, D. O. Mexico City; Instituto Politecnico Nacional (1973). 53p. (In Spanish).

Thesis.

The mounting of the magnetic IV spectrograph in its provisional and definitive positions is described in detail. The focusing and calibration was made with nuclear reactions and with ^{210}Po α particles. The equations for the particle energy as a function of its magnetic rigidity and the kinematics of the reaction are presented and resolved. The energy levels from (d,p) reactions on ^{40}Ca and ^{48}Ca were studies at incident deuteron energies of 7, 8, 9, 10, and 11 MeV at an angle of 90°40'. The results showed that the number of excited states of ^{41}Ca is much greater than in ^{49}Ca, an indication that ^{48}Ca is a much more closed nucleus than ^{40}Ca. (JSR)

15622 AUTOMATIC MOESSBAUER SPECTROMETER BASED ON THE SPECTROMETRIC SECTION OF A DIFFRACTOMETER. Butyugin, M. A. (Moscow Mining Inst.). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1448-1449(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1147-1148(Sep 1972).

A Moessbauer spectrometer working in the constant-velocity mode, with automatic periodic changes in velocity and automatic recording of the accumulated (stored) information at the end of each period, is described. This spectrometer facilitates measurements in any specified velocity range, and is based on the standard spectrometric section of an SSD-1 diffractometer. (WHK)

15623 BONE DENSITY SCANNER USING GAMMA RAY ATTENUATION WITH A Ge(HP) DETECTOR (ENGINEERING MATERIALS). (Brookhaven National Lab., Upton, N. Y.). (CAPE-2348).

6 drawings.

A one-dimensional mechanical scanning system has been constructed and evaluated in which a 150 mCi ^{241}Am source (60 keV γ-ray) and Ge(HP) detector traverse an object in a transmission geometry. If the object is an arm immersed in water, the γ-ray absorption by the internal bone directly measures the intercepted bone mass and delineates linear variations in bone mass. The use of a high-energy resolution detector provides for very complete scatter rejection with minimal shielding. It also suggests the use of multiple γ- or x-ray lines from the source. Measurements of phantoms indicated systematic precision of $\lesssim$1% for scans taking a nominal 5 minutes. Differential sensitivity was found to about 3% for scans of the same useful length of time. (auth)

15624 PAIR SPECTROMETER USING MAGNETOSTRICTIVE READ-OUT SPARK CHAMBERS. Bertin, P. Y.; Castor, J.; Devaux, A.; Isabelle, D. B.; Lieutier, M.; Planchard, E. J. (Clermont-Ferrand Univ., France). Rev. Phys. Appl.; 8: No. 1, 67-73(Mar 1973). (In French).

A pair spectrometer provided with spark chambers and a magnetostrictive readout is described. It was used to study photon materialization in the field of atomic electrons. A Varian 620 computer allows an on-line storing of the data on magnetic tapes. (FR)

15625 GAMMA SPECTROMETER SYSTEM WITH MEANS FOR THE CONTINUOUS IN SITU EXAMINATION OF IRRADIATION DEVICES. Perves, J. P.; Michel, F.; Chevallier, M. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 177, 45-50(Jan 1973). (In French).

A gamma spectrometry and gamma scanning apparatus was installed in the SILOE (32 MW) swimming pool reactor. The apparatus is intended for studies of the behavior of the fission product distribution in the irradiated fuels and their test rigs during irradiation. In each spectrometric operation, the rigs are removed from the reactor core but remain in the pool without any dismantling or removal of the sample. The purpose behind these studies is the investigation of the migration of these fission products in the fuel and the coolant and the determination of their fixing on the rigs and loop structures. The performance of this apparatus is such that the behavior of short lifetime fission products can be studied in spite of the very high activities and the presence of numerous gamma activation lines. (FR)

High Energy Physics Instrumentation

15626 (ITEF-851) METHODS OF ALIGNMENT AND PARAMETER DETERMINATION OF ZhVK-205 ITEhF LIQUID-HYDROGEN BUBBLE CHAMBER PHOTOGRAPHY SYSTEM. Dronyaev, V. P.; Surin, V. P. (Gosudarstvennyi Komitet Po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 18p. (In Russian). INIS.

Problems of realignment of the subassemblies of the photographic system, and of determining its parameters and evaluating its errors are discussed. The solution to these problems is connected with features of construction of the bubble chamber and photographic system. The experience of about 200,000 photographed events in the liquid hydrogen bubble chamber was drawn upon. (tr-auth)

15627 (IFVE-SPK-71-56) GOTICA: A PROGRAM WHICH GENERATES IMAGES OF CHARGED PARTICLE TRACKS IN BUBBLE CHAMBER PHOTOGRAPHS. Description of the Pro-

gram. Kistenev, E. P. (Gosudarstvennyi Komitet Po ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 44p. (In Russian). INIS.

The GOTICA program is described which is capable of generating charged particle track representations in bubble chamber photographs. The program was developed by the IFVE bubble chamber group for processing photographs from the two-meter propane chamber. A method for generating fictitious tracks permits one to allow for practically all of the physical effects which exert an influence on a particle trajectory in a medium: multiple scattering, large-angle scattering, ionization losses, bremsstrahlung, and inhomogeneity of the magnetic field in the three coordinates. The program is stored on magnetic tape, and operates on the BESM-6 computer. (tr-auth)

15628 (JINR-D-6840, pp 210-218) WIRE SPARK CHAMBERS SYSTEMS ON LINE WITH A COMPUTER FOR EXPERIMENTS ON EXTRACTED JINR PROTON SYNCHROPHASOTRON BEAMS. Azhgirei, L. S.; Kuznetsov, A. S.; Meshcheryakov, M. G., Stoletov, G. D.; Filozov, A. F. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

15629 (JINR-D-6840, pp 219-225) JINR MAGNETIC SPARK CHAMBER SPECTROMETER (INTRODUCTION TO THE OPERATION AND INITIAL RESEARCH PROGRAMS). Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From second symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

15630 (RI-73/5) STUDY AND MANUFACTURE OF A MAGNETIC DETECTOR WITH A LARGE SOLID ANGLE FOR COLLISION RINGS. Cordier, A. (Paris Univ., Orsay (France)). May 1973. 150p. (In French). Dep. NTIS (U. S. Sales Only) $9.50.

Thesis.

A magnetic detector was studied and developed for placement in the experimental zone of collision rings. This magnetic detector necessitated the conception of cylindrical proportional multiwire chambers which permit a cathodic detection. The magnetic detector and its experimental possibilities are described in detail. The structure and the operational principles of proportional multiwire chambers are reviewed. The tests made on chambers of very small dimensions are then described. These tests permitted the design and construction of cylindrical proportional multiwire chambers. Two prototypes of these chambers were constructed and their performance is described. These prototypes had extremely low matter. They had cathodic detection which permitted determination without ambiguity of all the coordinates of passage points of particles. There was total detection in an azimuthal angle of 2π. (JSR)

15631 (RL-73-19) DESIGN LOADING ANALYSIS OF A TRACK SENSITIVE TARGET IN A BUBBLE CHAMBER. Mack, B. (Rutherford High Energy Lab., Chilton (England)). May 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

An investigation has been carried out to determine the magnitude of the hydrodynamic loads on a liquid hydrogen filled track sensitive target under continuous operation in a bubble chamber. The subject is discussed under the following heads: basic pressure wave equations, velocity of fluid equations, and pressure wave stress analysis. (UK)

15632 (RL-73-26) OPERATION OF TRACK SENSITIVE TARGETS IN A NEON HYDROGEN BUBBLE CHAMBER. Leutz, H.; Williams, P. R. (Rutherford High Energy Lab., Chilton (England)). Apr 1973. 6p. (CONF-730531-2). Dep. NTIS (U. S. Sales Only) $3.00.

From international conference on instrumentation for high energy physics; Frascati, Italy (8 May 1973).

Two track sensitive targets have been successfully operated in the 1.5 m cryogenic bubble chamber at the Rutherford High Energy Laboratory. The first target was of stainless steel and plexiglas construction, the second was made wholly of plexiglas. The bubble chamber was filled with mixtures of neon and hydrogen with neon concentrations in the range 43 molecular percent to 82 molecular percent. Chamber operating conditions were achieved which gave satisfactory track quality in both the target and the chamber over the neon concentration range investigated. A total of 1.5×10^6 pictures for HEP research have been taken with this system. (auth)

15633 EFFECT OF CHERENKOV RADIATION ON ALCOHOLS. Koch, F.; St. Tamas; Cosma, C. Stud. Univ. Babes-Bolyai, Ser. Phys.; 18: No. 1, 87-89(1973). (In Rumanian).

The difference between Cherenkov detection and detection with liquid scintillators was investigated. The efficiency of Cherenkov detection decreases as a function of the refractive index and the volume of the sample. (tr-auth)

15634 TOTAL ABSORPTION DETECTORS AND THEIR APPLICATIONS TO HIGH ENERGY PHYSICS. Hofstadter, R. (Stanford Univ., CA). New Phys. (S. Korea); 12: No. 4, 189-203 (Dec 1972).

The development and operation of NaI(Tl) scintillation total absorption shower counters (TASC) and total absorption nuclear cascade counter (TANC) detectors are discussed. The Harshaw Chemical Company has produced NaI(Tl) crystals of 30" in diameter and 10" in thickness for use as a TANC detector. Applications of TASC discussed include studying the $\pi^{\pm} + p$ interaction at 14 GeV/c, cross section measurements for $e^+ + e^-$ interactions at SPEAR, and for use in HEAD satillite-borne gamma ray telescope. (WHK)

15635 DATA COLLECTION AND ANALYSIS SOFTWARE SYSTEM FOR A DENSELY PACKED, THREE-DIMENSIONAL SPARK GRID CHAMBER ARRAY WITH INTERNAL TARGET WITH RESULTS FOR A π^- EXPOSURE AT 1080 MeV/c. Stubblefield, F. W. Nashville; Vanderbilt Univ. (1972). 250p. University Microfilms Order No. 73-14,533.

Thesis (Ph. D.).

The underlying principles, structure, and performance of a software system used to collect and analyze data from a special type of spark chamber array are described. special features of the array include the following: 1. dense packing—the array contains 42 electrodes spaced along a central axis length of less than four inches; 2. three-dimensional event reconstruction—tracks at large angles ($\simeq 65°$) with respect to the central axis of the chamber array can be detected and; 3. internal target—the array has a polyethylene target within the electrode region so that detection of secondary particles can begin at a minimal distance (~0.1 cm) from the event production vertex. A description of the spark chamber array, readout system, triggering counters, and data collection system is given. The corrections required to locate spark coordinates with respect to an easily visualized laboratory coordinate system are detailed. The problems encountered in collecting a large number of events (~30) in a time consistent with the spill time of modern high energy particle accelerators (~500 msec) with a small on-line computer are discussed and a program code capable of performing this task is presented. An off-line analysis system to perform the tasks of sorting the spark numbers generated by the array into groups corresponding to particle tracks and reconstructing the tracks into three-space events is detailed. Included in this system are programs to kinematically test reconstructed events. Code for reconstructing two-prong scatter events, single-charged particle decay events, and three-prong events is included in the system. The importance of deducting a suitable model of spark formation in the chamber gap is discussed and the details and results for such a model are presented. To this end, a review of the principles of spark formation in a gas is included. The analysis system has been tested on data obtained in a π^- exposure at 1080 MeV/c incident momentum. It is shown that the system is capable of reconstructing the above mentioned event topologies. (Diss. Abstr. Int., B)

Radiometric Instruments

15636 HORIZONTAL DISPLACEABLE BEAM SNOW GAGE. Vuillot, M.; Guillot, P. (Electricite de France, Grenoble). Meteorologie; No. 10, 343-357(Apr 1969). (In French).

From 10th international congress on alpine meteorology; Grenoble, France (2 Sep 1968).

The development of a gamma-ray absorption snow gage which would transmit by radio daily observations made high in the mountains, and would only require servicing once a year is described. A vertical beam device was put into service in 1964. This device was however limited to measurements of up to 4 meters of snow or 1.20 meters of water. During the last two winters, experimental work has been carried out on a horizontal displaceable beam snow gage. The operation of this gage involves the simultaneous displacement of the radioactive source (30 millicuries of ^{137}Cs) and the GM detector in two tubes 60 cm apart at a velocity which is proportional to the counting rate. A radio signal is transmitted every decimeter moved in the upward direction in the snow. When the system emerges from the snow, it stops and redescends to its rest position. The number of signals transmitted represents the number of decimeters of snow and the time duration separating two signals (4 to 20 seconds) represents the density of each layer of snow. The results obtained during the winter of 1967/1968 with a snow gage situated 35 km from Grenoble are presented. (FR)

15637 MONITORING SYSTEM UTILIZING AN AUTONOMOUS IONIZATION DETECTOR. Langeron, R. J. French Patent 2,123,165. 8 Sep 1972. Filed date 27 Jan 1971. 4p. (In French).

An autonomous ionization detector system enabling gas, smoke, and aerosols to be detected is presented. The system is characterized by its detection warning system, the signal being transmitted by radio. In this way it is possible to utilize the detector in regions exposed to danger from fires. (FR)

15638 EFFECT OF VARIOUS FACTORS ON RADIATION THICKNESS GAGES. Yamamoto, I.; Tsutsumi, H.; Tamiya, S.; Terada, M. (Kobe Steel, Ltd., Japan). Tetsu To Hagane; 59: No. 5, 623-628(Apr 1973). (In Japanese).

Thickness measurements using radiation are influenced by various factors such as steel compositions, water film on the surface of steel strip, location of steel strip, temperature variation, and heat treatments. Factory tests to determine the effects of the above factors were performed. Results are summarized as follows: (1) the effect of the composition can be calculated theoretically, and the theoretical results agree with those obtained in the factory tests; (2) the compensation for strip temperature variations varies in each mill. It can, however, be neglected in the range of ±50°C; and (3) effects of steel density change due to the hot rolling could not be detected in these tests. (auth)

15639 DEVELOPMENT OF A HOT-STRIP CROWN METER USING GAMMA RAYS. Miyagawa, K.; Ichijima, I.; Egashira, T. (Nippon Steel Corp., Tokyo). Tetsu To Hagane; 59: No. 5, 642-652(Apr 1973). (In Japanese).

Strip crown measurements have been requested by strip mills for the production of uniform strip. An on-line strip crown meter has been developed using ^{241}Am. The problems encountered in the development of the crown meter are discussed. The main features of this instrument are that it uses a relatively large radiation source and a narrow rectangular γ-ray beam. It takes about one minute to scan the entire width of strip and an accuracy of two microns of thickness was obtained. (auth)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

15640 (SLA-73-5617) EXPERIMENTAL NEUTRON DAMAGE EQUIVALENCES UTILIZING DEVICE PARAMETERS. Coppage, F. N. (Sandia Labs., Albuquerque, N. Mex.). 1973. 21p. (CONF-730703-5). Dep. NTIS $3.25.

From conference on nuclear and space radiation effects; Logan, Utah, USA (23 Jul 1973).

When considering neutron-induced damage to transistors, it is desirable to relate the damage caused by one spectrum to that of another. Recent experimental work shows that the damage curves based on displacements in bulk silicon are an over simplification when applied to devices, and give significant errors. Using the experimental technique described, it is possible to compare the damage of different spectra using the actual device parameter of prime interest. Results obtained using this technique show that damage induced in devices involves several damage mechanisms and is more complex and severe than that predicted from displacements alone. While damage ratios for different spectra may be quantitatively obtained, a totally satisfactory explanation for the increasing damage for spectra becoming increasingly "harder" is not presently available. The difficulty of explaining the damage ratios obtained that are larger than anticipated is compounded by the fact that these ratios appear to be dependent upon the operating point of the device, the device parameter used as a basis, and possibly the device type. (auth)

15641 (SLA-73-5618) ROOM TEMPERATURE ANNEALING OF IONIZATION-INDUCED DAMAGE IN CMOS CIRCUITS. Habing, D. H.; Shafer, B. D. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 19p. (CONF-730703-6). Dep. NTIS $3.00.

From conference on nuclear and space radiation effects; Logan, Utah, USA (23 Jul 1973).

The effects of ionization on MOS devices in the early time frame after exposure to a radiation source are functions of the radiation source and device bias time profiles. A discussion, supported by a comprehensive series of experiments, of the time dependence of ionization induced damage to complimentary MOS (CMOS) devices is presented. Two distinct annealing or recovery mechanisms were investigated: (1) room temperature annealing in the absence of radiation, and (2) radiation enhanced room temperature annealing. Experiments were performed using both electron and γ-ray sources with ionization rates ranging from 10^3 rads(Si)/sec to greater than 10^{11} rads(Si)/sec and observation times extending from 1 msec to 10^5 seconds. The experiments demonstrate that ionization induced damage to positively biased MOS devices, such as the n-channel devices in CMOS circuits, can be annealed appreciably at room temperature by additional irradiation of the device with zero gate bias. Thus, when operation of CMOS circuitry during or immediately following radiation exposure is of interest, the experimental semi-permanent type radiation damage data typically reported must be carefully evaluated. (auth)

15642 (SLA-73-5631) RADIATION FAILURE MODES IN CMOS INTEGRATED CIRCUITS. Burghard, R. A.; Gwyn, C. W. (Sandia Labs., Albuquerque, N. Mex.). Jul 1973. 30p. (CONF-730703-4). Dep. NTIS $3.50.

From conference on nuclear and space radiation effects; Logan, Utah, USA (23 Jul 1973).

The radiation sensitivity of commercial and laboratory complimentary metal oxide semiconductor (CMOS) processes has been investigated. Failure levels for CMOS circuits have been related to transistor threshold voltage shifts and typical inverter failure modes. CMOS inverter characteristics have been measured as a function of the ionizing radiation exposure for devices fabricated by 10 different manufacturers and representing a total of 15 different processes. By selecting certain commercial processes, CMOS circuits can be obtained which will operate after exposure to an ionizing radiation dose greater than 10^6 rads (Si). (auth)

15643 INFLUENCE OF NEUTRON BOMBARDMENT ON THE LOW FREQUENCY NOISE PROPERTIES OF MDP-TRIODES. Potemkin, V. V.; Kashkarov, P. K. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 9, 1598-1599(Sep 1972).

Translated from Radiotekh. Elektron.; 17: No. 9, 1995(Sep 1972).

The influence of neutron bombardment on the volt-ampere and noise characteristics of MDP-triodes was studied. The MDP-triodes were irradiated with a neutron flux of 10^{12} to 10^{13} n/cm^2 at 14 MeV. The effects on the volt-amp characteristics were minor but the noise properties were changed significantly. (WHK)

15644 METHOD OF INVESTIGATING SEMICONDUCTOR RECTIFIERS. Kholopkin, A. I.; Chepek, A. V.; Gnesina, M. K.; Kol'tsov, G. I.; Tolchenov, Yu. M.; Kireev, P. S. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 9, 1597-1598 (Sep 1972).

Translated from Radiotekh. Elektron; 17: No. 9, 1993-1994.

A portable pulsed x-ray generator for studying the time response of semiconductor amplifiers to radiation is described and the procedure for studying the pulsed responses of p–i–n silicon diodes is outlined. (WHK)

15645 EFFECT OF THE NATURE OF THE OXIDE ON THE DEGRADATION OF MOS STRUCTURES BY IRRADIATION. Chapeau, A.; Buxo, J.; Sarrabayrouse, G. (Centre National de la Recherche Scientifique, Toulouse). Compt. Rend., Ser. A, B; 276: No. 12, 459-462(19 Mar 1973). (In French).

An experiment is described which demonstrates that excitation of only the metal–silica heterojunction can lead to new surface states at the silica-silicon interface. This phenomenon occurs only with oxides prepared in damp atmospheres and irradiated with a positive potential maintained between the grid and substrate. (FR)

15646 EFFECT OF RADIATIONS ON M-O-S DEVICES. Singh, B. R.; Srivastava, R. S. (Banaras Hindu Univ., India). Int. J. Electron.; 34: No. 6, 785-793(Jun 1973).

The behavior of the capacitance-voltage (C-V) characteristics of M-O-S capacitances prepared on n-type (10 Ω cm) silicon surfaces has been described. The effect of gate voltage during irradiation on the C-V characteristic, radiation-induced excess charge with time and the annealing of the device due to temperature and uv radiation are reported. The effect of visible light on the devices is also reported. (auth)

Miscellaneous Instruments

Refer also to abstracts 15286, 16215, 16217, 17465, 17613, 17714, 17782, 17811, and 17826.

15647 (CEA-CONF-2251) SEMICONDUCTOR DETECTOR X-RAY FLUORESCENCE ANALYSIS SYSTEM. Friant, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 19 Feb 1973. 39p. (In French). (CONF-721225-1). Dep. NTIS (U. S. Sales Only) $4.00.

The essential composition, functioning, and characteristics of an energy dispersive analysis unit utilizing a Si(Li) detector, excitation, spectrometer, and data processing are presented. The analytical properties of such a system are studied using

currently available results on the resolution, counting rate, and the detector input window with an electric resolution of 90 eV and a physical resolution of 110 eV for light elements (N to Si), and 155 eV at 5.9 keV (K line of Mn). (FR)

15648 (HEDL-SA-528) HIGH FREQUENCY INSTRUMENT FOR MATERIAL STRAIN MEASUREMENTS. Billeter, T. R. (Hanford Engineering Development Lab., Richland, Wash.). 6 Apr 1973. Contract AT(45-1)-2170. 29p. (CONF-730611-12). Dep. NTIS $3.50.

From 19th annual meeting of the American Nuclear Society; Chicago, Illinois, USA (10 Jun 1973).

A method and instrumentation operating at microwave frequencies for measuring uniaxial strain of a material are described. Achievement of the ultimate objective would permit continuous, accurate (to 10^{-6}-in.), and responsive (~milliseconds) strain measurements of specimens subjected to radiation environments at 1200°F. The employed cylindrical sensor (0.43-in. ID by 0.54-in. long), attached to the specimen, varies in length for specimen strains. As the sensor resonates at a microwave frequency dependent upon length, incident energy is absorbed at a frequency related to specimen strain. The sensor output signal, frequency of energy absorption, can be monitored with an accuracy of 1 in 10^7 parts, thereby permitting determination of strains of 1×10^{-6}-in. Measurement accuracy $\sim 2 \times 10^{-5}$-in. was achieved with apparatus operating in the 12.4 to 18.0 GHz frequency band. Results of tests with an experimental unit operating at ~36,000 MHz and 1000°F in a 92% argon-8% hydrogen gas environment indicated no degradation of operating characteristics after 2000 hours of use. During the first hundred hours of test, programmed strain displacements were introduced at selected interim times. For a total displacement of 7×10^{-3}-in., the greatest deviation of the sensed value, as compared with the input, amounted to 6×10^{-5}-in. The technique is readily adaptable for nearly simultaneous monitoring of multiple specimen test assemblies. Fabrication of the sensor of metal only permits direct immersion in liquid metal or other reactive coolants. Use of a typical instrument providing material strain measurements with digital or analog readout, a range of 10^{-6} to 10^{-1}-in., and a time response of milliseconds should assist technologists in determining the physical characteristics of materials being subjected to environments expected in fast flux nuclear reactors. (auth)

15649 (RL-73-34) DESIGN FOR THERMAL NEUTRON POLARIZATION ANALYSIS DIFFRACTOMETER WITH A FILTER CONTAINING POLARIZED SAMARIUM-149 NUCLEI AS THE SPIN ANALYZER. Williams, W. G. (Rutherford High Energy Lab., Chilton (England)). May 1973. 106p. Dep. NTIS (U. S. Sales Only) $7.50. UK pounds 1.00.

A polarization analysis diffractometer is described for use with thermal neutron beams. In principle the instrument may be used to study both elastic and inelastic scattering processes and for the former the beam fluxes available from a medium flux reactor are shown to be sufficient to enable many spin-dependent cross-sections to be determined to a good statistical accuracy. The beam polarization is produced in the usual way by reflection from a magnetized cobalt-iron polarizing crystal and the spin analysis is carried out by a new type of neutron polarizing filter containing polarized samarium-149 nuclei. The proposal is the outcome of a series of recent studies related to the polarization analysis technique, and is presented in five parts: general description of the polarization analysis technique; polarizing filters as spin analysers for polarization analysis experiments; a polarization analysis diffractometer with a polarizing filter as the spin analyser; engineering aspects of the polarization analysis diffractometer design; and the scientific case for a polarization analysis facility. (auth)

15650 SINGLE CHANNEL AMPLITUDE ANALYZER. Bibok, G. Atomki (At. Kut. Intez.) Kozlem.; 15: No. 1, 41-48(1973). (In Hungarian).

A single-channel amplitude analyzer on IC-s is described. The instrument can be successfully used at different input pulse shapes; it has a short dead time and stable threshold of discrimination and channel width. (auth)

15651 NEW MASS SPECTROMETER/MASS SPECTROGRAPH. Bakker, J. M. B. (Shell Research Ltd., Sittingbourne, Eng.). J. Mass Spectrom. Ion Phys.; 11: No. 3, 305-307.

The principle of impulse sweeping of deflection plates for mass separation of ions is briefly discussed. (WHK)

15652 NEW TYPE OF ION DETECTOR HAVING SPECIAL ADVANTAGES FOR THE STUDY OF METASTABLE TRANSITIONS OF ORGANIC IONS PRODUCED BY ELECTRON IMPACT. Daly, N. R.; McCormick, A.; Powell, R. E.; Hayes, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Mass Spectrom. Ion Phys.; 11: No. 3, 255-276(May 1973).

An improved version of the scintillation detector described by Daly, McCormick and Powell which uses a retarding potential to set the upper limit on the energy of ions which may be recorded has been developed. The detector can now be used in place of an electron multiplier without penalty in respect to sensitivity, linearity and stability. In addition, it provides methods of uniquely defining metastable decomposition pathways, of measuring energy release in these reactions and of directly observing two-stage decompositions. A new fast switching system enables conventional spectra and spectra with enhanced metastable peaks to be simultaneously displayed. Alternatively this switching system allows spectra free of metastables to be produced, which offers some advantage for computerized data acquisition systems. (auth)

15653 COMPUTER EVALUATION OF A LINEAR ACCELERATOR RADIOFREQUENCY MASS SPECTROMETER USING FREQUENCY MODULATION. Spoerri, P. A.; Peterson, N. C. (Polytechnic Inst., Brooklyn). J. Mass Spectrom. Ion Phys.; 11: No. 3, 223-242(May 1973).

The performance of the Redhead radiofrequency (rf) mass spectrometer using various shapes and amplitudes of the rf waveform was studied by computer simulation. For low rf amplitudes the resolution is very low except for extremely small current-efficiencies. The resolution improves with increasing rf amplitude, but with increasing distortion of the ion peak shape due to acceleration of resonant ions out of phase with the applied rf signal. The use of a frequency modulated waveform improves the spectrometer as a linear accelerator, with the energy gain a linear function of rf amplitude. At high rf amplitudes the resolution in the frequency modulated case is about half that for the unmodulated sine wave. In the frequency modulated mode of operation the time of flight of resonant ions is proportional to the square root of their mass. By gating the ion source and the detector a further improvement in resolution is obtained. The ability of the spectrometer to focus a single ion peak in both energy and time offers some advantages over a conventional time-of-flight mass spectrometer. (auth)

15654 ELECTRONIC SYSTEM FOR HIGH SENSITIVITY AND HIGH STABILITY MASS SPECTROMETRY. Part II. Electronic Set Up for an On-line Mass Spectrometer. Goby, G.; Nguyen, L. D. (Institut de Physique Nucleaire, Orsay, France). J. Mass Spectrom. Ion Phys.; 11: No. 3, 215-221(May 1973).

An electronic set up was established for the study of very short-lived (>10 μs) isotopes arising from nuclear reactions. This was done by using a mass spectrometer on-line with an accelerator's beam. (auth)

15655 ELECTRONIC SYSTEM FOR HIGH SENSITIVITY AND HIGH STABILITY MASS SPECTROMETRY. Part I. Electronic Set-up for an Off-line Mass Spectrometer. Nguyen, L. D.; Goby, G.; Rosenbaum, B. (Institut de Physique Nucleaire, Orsay, France). J. Mass Spectrom. Ion Phys.; 11: No. 3, 205-213(May 1973).

An electronic set up which gives very high sensitivity to a mass spectrometer is described. This sensitivity allows the detection of one ion per minute at the collector. Mass scanning is implemented by a staircase-shaped variation of the accelerating voltage, synchronized with the gating of a multiscaler. The performance shows the very good stability of the assembly. (auth)

15656 RECENT DEVELOPMENTS IN X-RAY FLUORESCENCE ANALYSIS AND ITS APPLICATIONS. Bacso, J.; Berenyi, D.; Szalay, S. Atomki (At. Kut. Intez.) Kozlem.; 15: No. 1, 1-15(1973). (In Hungarian).

The principles, some recent results of radioisotope x-ray fluorescence analysis, and its applications are surveyed. The equipment is shown and its characteristics are illustrated via some results of measurements. (auth)

15657 RADIATION TIMING DEVICE. Berk, S. (To Secretary of the Army). U. S. Patent 3,733,489. 15 May 1973. Filed date 7 Jul 1971. 6p.

A radiation timing device for use in fuzes for bombs, shells, mines, and the like is described. The constant emission of radioactivity from a radiation source is used to measure time. The device consists of a source, a shutter or absorber placed between the source and a radiation detector and counter. When a predetermined number of emissions is counted a switch activates the device. (Official Gazette)

15658 PROCESS FOR THE FABRICATION OF A COLLIMATOR FOR NEUTRONS OR GAMMA RAYS. Barth, H. German Patent 1,572,602. 18 Jun 1970. Filed date 12 Dec 1967. (In German).

A procedure is described for the fabrication of a collimator for neutron and gamma rays that is composed of a bundle of lamella separated at the extremities by wedges, threaded and fixed to a

tube. It is characterized by an arrangement on the wall of the tube that makes it possible to apply a mechanical tension to the bundle in relation to the wall of the tube and in the direction of its axis and which makes it possible to turn the bundle around the axis of the tube. (TSS)

15659 CONSTRUCTION AND PERFORMANCE OF A MASS SPECTROMETER FOR RADIOACTIVE MATERIALS. Komori, T. (Japan Atomic Energy Research Inst., Tokai); Tamura, S.; Gunji, K.; Oda, Z. Shitsuryo Benseki; 21: No. 1, 27-35(Mar 1973). (In Japanese).

A 60°, 305 mm radius, triple filament, surface ionization type mass spectrometer was constructed for the routine isotopic analysis of radioactive materials such as transuranium and fission product elements. The machine is basically a modification of the NBS-type mass spectrometer. Safety and ease of maintenance and handling were improved by using the closed vacuum system with two ion pumps. Some results on the performance test are also described. (auth)

15660 AUTOMATIC RATIO READOUT SYSTEM FOR A DOUBLE COLLECTION MASS SPECTROMETER. Beaver, E. M. (McMaster Univ., Hamilton, Ont.). Shitsuryo Bunseki; 21: No. 1, 37-44(Mar 1973). (In Japanese).

An improved isotope ratio readout system for a six-inch ratio mass spectrometer has been developed that offers the advantages of automatic operation, precision equivalent to or somewhat better than other systems, and low cost. A pair of solid-state vibrating reed electrometers are used to measure the ion currents from two isotopes. These are interfaced to a frequency counter, operated in ratio mode, through two voltage-to-frequency converters A digital programer is used for automatic operation. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

15661 (CEA-CONF-2285) LEGAL OUTLINES FOR CARRYING OUT THE INTERNATIONAL PLAN FOR AN ISOTOPE SEPARATION PLANT. Vial, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 14p. (In French). (CONF-730341-2). Dep. NTIS (U. S. Sales Only) $3.00.

From international cooperation in reactor material and nuclear fuels conference; Paris, France (2 Mar 1973).

The realization of a plant of this nature poses a series of choices, i.e., location of site, technology utilized, and partners chosen. At the final development and operational stage, relations between the various partners, the suppliers, and the clients are required. (FR)

15662 (CONF-730803-3) HEAT TRANSFER AND PUMPING POWER PERFORMANCE IN TUBE BANKS: FINNED AND BARE. Cox, B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 23 Apr 1973. 10p. ASME, New York $3.00.

From national heat transfer conference; Atlanta, Georgia, USA (5 Aug 1973).

Methods are presented for comparing the simultaneous heat transfer rates and pumping power expenditures of tube banks. Data from the open literature plus new experimental data are used to determine the effects that tube pitch has on finned and bare tube bank performances. By evaluating the basic design data of different geometries at a common tube diameter, the performance limitations imposed by manufacturing are established. (auth)

15663 (K-Trans-69) URANIUM ENRICHMENT METHOD WITH THE CENTRIFUGAL SEPARATOR. Observations from the Patent Field. Asano, N. Translated from Genshiryoku Kogyo; 19: No. 1, 35-44(Jan 1973). 24p. Dep. NTIS $3.25.

Patents contained in the Japanese Patent Office on uranium enrichment by centrifugation are reviewed. (TFD)

15664 (KFK-1801) OPERATING LIMITS OF A TECHNICAL SEPARATION NOZZLE STAGE FOR U-235 ENRICHMENT. Seidel, D.; Sieber, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). May 1973. 35p. (In German). Dep. NTIS (U. S. Sales Only) $3.75.

Thesis. Submitted by U. Sieber to Technische Hochschule, Karlsruhe (West Germany).

When operating a technical separation nozzle stage in an enrichment cascade disturbances may cause such significant deviations from the design pressures and concentrations that under adverse conditions the operating limits defined for the stage components may be exceeded. These operating limits of the integrated separation nozzle stage consisting of a driving motor, compressor with cooler, and separation tank are the limit of capacity of the motor, the pulsation point of the compressor, and the temperature limit of the impeller. For a technical separation nozzle stage the compressor characteristics as well as the characteristic curves of a technical separation element are determined experimentally with UF_6/He mixtures containing 3 to 7 mol % of UF_6 and at pressures ranging from 300 to 600 torr. The operating points of a separation nozzle stage determined by combination of the characteristics of both compressor and separation element as well as their operating limits are elucidated in a process diagram. It appears that taking the design point as the basis, the distance from the surge point varies but insignificantly with changes in concentration. By contrast, pressure reductions are possible only down to 200 to 300 torr on account of the surge point. With an increase in pressure and/or concentration the rate of power input increases considerably which means that a sufficient margin of power must be provided for the compressor motor in an enrichment plant. It is shown that the temperature limit of the impeller is identical to the concentration limit up to some 6.2 mol %. Moreover, it is demonstrated that changes in the characteristics of the compressor and separation elements are visible from the process diagram. (auth)

15665 CALCULATION AND EVALUATION OF INTEGRAL CHARACTERISTICS OF IDEAL TWO-COMPONENT CASCADES WITH ARBITRARY ENRICHMENT PER STAGE. Kolokol'tsov, N. A.; Laguntsov, N. I.; Sulaberidze, G. A. At. Energ. (USSR); 34: No. 4, 259-263(Apr 1973). (In Russian).

The main characteristics required for the calculation and evaluation of the effectiveness of cascades with arbitrary enrichment per stage are considered. A differential equation of partitive potential was obtained for the calculation of the concentration increment per stage. This equation was solved and is valid for the entire range of concentrations when dividing along a certain channel. A method of evaluating the total flux by the stage characteristics and external parameters of the cascade is proposed. It is shown that for certain restrictions relative to the absolute magnitude of enrichment the conclusion is maintained that nonsymmetrical cascades with a flux division coefficient $\Theta = 2/3$ are the most advantageous. (auth)

Isotopic Power Sources

Refer also to abstracts 15418, 15420, and 15985.

15666 IN-PHANTOM DOSIMETRY OF PROTOTYPE PLUTONIUM HEAT SOURCES FOR CIRCULATION-SUPPORT SYSTEMS. Cross, F. T.; Sheppard, J. C. (Battelle Pacific Northwest Labs., Richland, WA). pp 497-506 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The dose rates from various implanted ^{238}Pu heat sources have been measured and calculated. The source material was encapsulated medical grade plutonium metal and plutonium dioxide of nominal 30 W strength. The latter material was placed in a prototype circulation-support subsystem. The tissue-equivalent phantoms were a large homogeneous right-circular cylinder and a man-simulating REMAB phantom. Dose rates were calculated using a modified point-kernel code QAD-P5A. The calculations were in good agreement with the measurements, at least in the regions where the photons and neutrons make their greatest dose contribution for a source enclosed in a circulation-support system. Dose rates to various organs and regions, both internal and external to a man-simulating phantom, are presented. The values are derived both from measurements and calculations. Neutron dose rates were measured with small tissue-equivalent proportional counters biased to exclude the photon contribution. Most of the neutron values were derived from measurements on ^{252}Cf which was used as a substitute for the plutonium sources. Photon dose rates were measured with small thermoluminescent dosimeters (TLD-700) known to be insensitive to the neutrons from californium and plutonium. Integrated and average body dose rates were derived from the measurements in the large homogeneous tissue-equivalent phantom. These values are presented for an artificial heart power source with a ten year mission life and therefore include the "growing-in" of the dose rates from the heat source impurities. These values are compared with past radiologic experience and conclusions are presented on the acceptability of an artificial heart device incorporating a medical grade plutonium heat source. (auth)

Radiation Sources

Refer also to abstracts 15729 and 15730.

15667 (CEA-N-1587) SPECTRAL DISTRIBUTIONS OF COBALT THERAPY UNITS. Legrand, J.; Morel, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1973. 24p. (In French). Dep. NTIS (U. S. Sales Only) $3.25.

The importance of scattered photons in cobalt-therapy units was demonstrated. The scattering was studied for different types of sources and for different irradiation units. The spectral distribution was determined in each case. It was demonstrated that for certain units, the scattered photons can reach 70%. (FR)

15668 X-RAY CASSETTES CONTAINING RADIOACTIVE MARKER SOURCES FOR IDENTIFYING PHOTOGRAPHIC FILMS. Bell, T. K. British Patent 1,311,656. 28 Mar 1973. Filed date 4 Jun 1969. 3p.

The x-ray cassettes described contain radioactive marker sources to provide identification of photographic films and to indicate their position in the cassettes. The marker sources take the form of a letter or letters, a digit or digits, or a symbol or symbols. Sheets may be used containing a radionuclide, masked with another material to yield the required markings on the photographic films; alternatively materials may be used containing a radionuclide and cut in the required shapes. Inks or paints may be

used, incorporating the radionuclide. The marker sources may contain fluorescent or phosphorescent substances the luminosity of which is enhanced sufficiently by the radioactivity to cause images of the symbols on the photographic films during the period the films are in the cassettes. (UK)

15669 DEGRADATION OF THE SPECTRAL DISTRIBUTION OF PHOTON BEAMS EMITTED FROM TELETHERAPY HEADS. Guiho, J. P.; Legrand, J.; Grinberg, B. (CEN, Saclay, France). pp 121-139 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

After examining the spectral distribution of photon beams emitted from teletherapy heads, it is shown that such beams contain a large fraction of degraded photons. Experiments with different source types and collimation arrangements reveal variations of 25 to 40% in the proportion of scattered photons. An experimental method capable of characterizing any measurement geometry is suggested. The importance of this degradation of spectral distribution both for dose measurements and for biological and medical applications is demonstrated. (auth)

Design and Fabrication

Refer also to abstract 15425.

15670 (CONF-730641 – 1) PREPARATION AND CALIBRATION OF ^{252}Cf NEUTRON SOURCES AT THE OAK RIDGE NATIONAL LABORATORY. Bigelow, J. E.; Van Cleve, J. E. Jr.; Knauer, J. B. Jr.; Williams, L. C. (Oak Ridge National Lab., Tenn.). 1973. 23p. Dep. NTIS $3.25.

From seminar on the use and calibration of intense sources of radiation; Santiago, Chile (18 Jun 1973).

The current method for the fabrication and calibration of ^{252}Cf neutron sources at the Oak Ridge National Laboratory is described. (TFD)

15671 (NP-19791) CALIBRATED ACTINIDE NUCLIDE SOURCES. The Preparation and Calibration of Alpha and Spontaneous Fission Emitting Sources of Radium and the Actinide Elements. (Atomic Energy Research Establishment, Harwell (England)). [nd]. 3p. Dep. NTIS (U. S. Sales Only) $3.00.

An account is given of the preparation and calibration of alpha active sources in the range 0.001 μCi to 100 mCi and of ^{252}Cf spontaneous fission sources. The individual nuclides that can be selected are listed for (a) high resolution and standard alpha sources, (b) alpha energy calibration sources containing a mixture of four or five long-lived nuclides, and (c) targets for the measurement of nuclear constants. Alpha radiation sources using ^{242}Cm are described under (a) air ionizing electrodes and (b) disc sources. ^{252}Cf sources for fission fragment energy calibration are described. An alpha spectrometry service is available for the analysis of mixtures of alpha emitting nuclides. (UK)

Industrial Uses

Refer also to abstracts 15564, 15565, 15587, 15592, 15695, and 15697.

15672 (AEC-tr-7436) TECHNOLOGY OF INHIBITION OF SPROUTING OF POTATOES BY MEANS OF RADIATION. Report on Laboratory Tests in the 1969–1970 Campaign. Sandert, F. 1971. Translation of Technologie de la Radio-Inhibition de la Germination des Pommes de Terre. Rapport sur les Essais de Laboratoire de la Campagne 1969–70. 85p. Dep. NTIS $6.25.

Results of laboratory tests in various EURISOTOP member states on the inhibition of potato sprouting by ionizing radiations are summarized. (TFD)

15673 TEN YEARS OF THE WORKING COMMITTEE ON ISOTOPE APPLICATION IN PETROLEUM AND GAS INDUSTRY. Vajta, L. (Orszagos Koolaj- es Gazipari Troeszt, Budapest). Izotoptechnika; 16: No. 5, 233-236(May 1973). (In Hungarian).

A review is presented of the past ten years' work of the Hungarian Working Committee on Isotope Application in the Petroleum and Gas Industry. (auth)

15674 USE OF RADIOISOTOPES IN THE PRODUCTION OF HYDROCARBONS IN HUNGARY. Dallos, I. (Koolaj- es Foeldgazbanyaszati Ipari Kutato Laboratorium, Budapest). Izotoptechnika; 16: No. 5, 237-243(May 1973). (In Hungarian).

Topics discussed include the use of radioisotopes in well logging, well control, localizing layer split, taking injection profiles, and inspection of pipe welds. (TFD)

15675 NUCLEAR TECHNIQUES IN GEOPHYSICAL DEEP BORING. Czegledi, I.; Marhoffer, J. (Orzagos Koolaj- es Gazipari Troeszt, Budapest). Izotoptechnika; 16: No. 5, 244-251 (May 1973). (In Hungarian).

The development of n-n, n-γ, γ-γ, and thermal and epithermal neutron well logging methods in Hungary is discussed. (TFD)

15676 IS DOSIMETRY REQUIRED IN RADIATION PROCESSING? Chadwick, K. H. (Euratom-Ital, Wageningen, Netherlands). pp 3-9 of Dosimetry in Agriculture, Industry, Biology, and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna; Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The need for routine dosimetry measurements in the three industrial radiation processes, chemical processing, radiosterilization of medical products, and food preservation, is considered. The radiation features of a typical ^{60}Co irradiation plant are reviewed briefly and the three processes are considered separately. It is concluded that dosimetry is not essential in the chemical processes, that either dosimetry or microbiological test samples can be used in the radiation sterilization process, and that dosimetry is required in food irradiation processing. It is also concluded that too much emphasis has been placed on dosimetry as a control of the process rather than on process control based on the parameters of the irradiation facility. (auth)

15677 APPLICATION OF RADIOACTIVE ISOTOPES IN PETROLEUM REFINERY. Vajta, L. N. (Nagynyomasu Kiserleti Intezet Asvanyolaj Minosegellenorzo Intezete, Budapest); Balint, T.; Peczeli, B. Izotoptechnika; 16: No. 5, 252-264(May 1973). (In Hungarian).

Analytical methods and instruments developed at the Hungarian Petroleum and Gas Research Institute and at the Research Institute of High Pressures are described. Metrological and industrial uses of radioisotope tracer techniques and determination of some elements are discussed. (auth)

LIFE SCIENCES

15678 (BNWL-1750(Pt.1)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1972 TO THE USAEC DIVISION OF BIOLOGICAL AND ENVIRONMENTAL RESEARCH. Volume I. Life Sciences. Part 1. Biological Sciences. Thompson, R. C. (ed.) (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1973. Contract AT(45-1)-1830. 113p. Dep. NTIS $3.00.

Separate abstracts were prepared for 42 sections of this report. (CH)

For abstracts of individual sections see: 15299, 15686, 15728–15730, 15769, 15773–15788, 15797–15811, and 17718–17721.

Radiation Effects on Biochemicals

Refer also to abstracts 15686, 15687, 17737, and 17740.

15679 (SU-326-P-32-X-2) DNA REPAIR IN BACTERIOPHAGE T4. Annual Progress Report. (Stanford Univ., Calif.). 1973. Contract AT(04-3)-326. 10p. Dep. NTIS $3.00.

Studies on T4 phage-induced, pyrimidine dimer-specific endonuclease included characterization of the termini created by endonucleolytic nicking of uv-irradiated DNA and endonuclease degradation of denatured uv-irradiated DNA. The T4 uv-endonuclease was used as a dimer-specific probe in a variety of studies. A technique is described for measurement of thymine dimers in ^{3}H-labeled uv-irradiated DNA. Studies on post-endonucleolytic events in dimer excision repair are discussed. UV and x radiation were used in studies on DNA repair in mammalian cells. (HLW)

15680 RADIATION EFFECTS ON α-CHYMOTRYPSIN IN AQUEOUS SOLUTION: PULSE RADIOLYSIS AND INACTIVATION STUDIES. Adams, G. E.; Baverstock, K. F.; Cundall, R. B.; Redpath, J. L. (Mount Vernon Hospital, Northwood, Eng.). Radiat. Res.; 54: No. 3, 375-387(Jun 1973).

Pulse radiolysis and steady-state inactivation methods have been used to study the separate roles of H, OH, and e^-_{aq} in the radiation-induced inactivation of aqueous α-chymotrypsin solutions. The effects of nitrous oxide and t-butanol used as selective free radical scavengers allow the inactivating efficiencies per unit G-value of OH, H, and e^-_{aq} radicals to be estimated; these are 0.137, 0.13, and 0.055, respectively, in neutral solution. The transient spectra observed show that both OH radicals and hydrogen atoms react mainly with tryptophan residues. Only about 15% of the hydrated electrons react with the cystine disulfide linkages; rupture of some of these linkages may lead to inactivation. It is suggested that the protective action of oxygen is due partly to the reactions of O_2 with enzyme radicals formed initially by reaction with OH. (auth)

15681 ENHANCEMENT OF TEMPLATE ACTIVITY OF CALF THYMUS AND RAT LIVER CHROMATIN BY γ-IRRADIATION. Mee, L. K.; Weiss, J. J.; Wheeler, C. M. (Univ. of Newcastle-upon-Tyne, Eng.). Radiat. Res.; 54: No. 3, 539-548(Jun 1973).

The effects of γ-irradiation of chromatin on its function as a template for the synthesis of RNA by DNA-dependent RNA polymerase were studied. Chromatin extracted from calf thymus and from rat liver, and RNA polymerase extracted from E. coli were used. The initial effect of irradiation is an enhancement of the template activity of chromatin. Kinetic studies suggest that the enhancement is not attributable to an increase in the number of enzyme binding sites on the chromatin available for transcription. At high doses, priming ability is inhibited. This inhibition is accompanied by an increased number of binding sites, but the polymerase bound to these newly created sites is apparently inactive in RNA synthesis. A complete nearest neighbor base frequency analysis of RNA synthesized on chromatin templates was made. The base composition and nearest neighbor frequencies of the RNA product indicate that the transcription from chromatin is asymmetric. With irradiated chromatin template, changes in base composition of the synthesized RNA were found, which may be attributable to a greater radiation sensitivity of the adenine–thymine base pair in the chromatin DNA. (auth)

15682 RADIATION-INDUCED BINDING OF PHENYLALANINE TRYPTOPHAN AND HISTIDINE MUTUALLY AND WITH ALBUMIN. Yamamoto, O. (Hiroshima Univ.). Radiat. Res.; 54: No. 3, 398-410(Jun 1973).

Phenylalanine, tryptophan, and histidine, in aqueous solution, can be bound to each other and to serum albumin when exposed to γ rays. The precipitation method with trichloroacetic acid was used to analyze the binding with albumin, and chromatography was used to analyze their binding with each other. During such radiation-induced binding of aromatic amino acids, the indirect participation of hydroxyl radicals from water was also observed using scavengers. It is proposed that this reaction may consist of a substitutional binding of phenyl type radicals with other aromatic rings. (auth)

15683 ULTRAVIOLET-LIGHT-INDUCED CONFORMATIONAL CHANGES IN DNA. Lang, H.; Luck, G. (Forschungszentrum fuer Molekularbiologie und Medizin, Gatersleben, Ger.). Photochem. Photobiol.; 17: No. 6, 387-393(Jun 1973).

Irradiation of DNA at 254 nm produced alterations in the secondary structure leading to changes in the circular-dichroism (CD) spectrum. A new Cotton effect around 320 nm, and a change in the rotatory strength of the CD maximum at 275 nm, was observed. Whereas the new negative maximum at 320 nm generally increased with increasing radiation dose, the maximum at 275 nm was enhanced at lower uv doses but diminished at higher doses. It was supposed that there are two different DNA conformations, the transition between which occurs at 15×10^4 ergs/mm^2. Below this dose, the DNA is in a partially closed and twisted state, but above it the DNA has a C-like conformation. It is suggested that those regions of the DNA containing altered conformation may act as recognition sites for repair. (auth)

15684 CHANGE IN THE OXIDATIVE PHOSPHORYLATION IN MITOCHONDRIA OF THE BRAIN AS A RESULT OF X-IRRADIATION. Cherkasova, L. S.; Mokhoreva, S. I.; Pikulev, A. T. (Inst. of Physiology, Minsk). Dokl. Akad. Nauk BSSR; 17: No. 4, 372-374(Apr 1973). (In Russian).

The role of the suprarenal hormones in radioinduced biochemical alterations was investigated, insofar as the hypophysis-suprarenal system plays a highly important role in reactions of the entire organism. The absorption of oxygen and the esterification of inorganic phosphorus in mitochondria separated by differential centrifugation from the grey and white matter of the brain of adrenalectomized white rats were studied 24 hr after being irradiated with a 100 R dose of x radiation. The data indicated that in the changes in intensity in oxidative phosphorylation during the action of ionizing radiation in relatively small dosage, an extensive role is attributed to the original functional state of the hypophysis-suprarenal system. (KSW)

Radiation Effects on Cells

Refer also to abstracts 15301 and 15787.

15685 (BNL-17966) USE OF DIFFUSION CHAMBER CULTURES IN THE STUDY OF NORMAL AND LEUKEMIC CELL PROLIFERATION IN MAN. Cronkite, E. P.; Boecker, W.; Carsten, A. L.; Chikkappa, G.; Joel, D.; Laissue, J.; Oehl, S. (Brookhaven National Lab., Upton, N. Y.). 1973. 16p. (CONF-730548-1). Dep. NTIS $3.00.

From second international workshop on hemopoiesis in culture conference; Warrenton, Virginia, USA (23 May 1973).

Autologous, caprine bone marrow cultured in diffusion chambers (DC) in normal and irradiated goats shows good growth of neutrophilic, erythroid, and macrophagic cells. The growth rate is greater in the irradiated host. The number of megakaryocytes is drastically reduced and then increases in DC as thrombopenia develops in the host. There is no erythroid proliferation in the normal host. The erythroid proliferation is correlated with radiation ablation of erythroid marrow of the host and neutrophilic proliferation with the abortive rise of neutrophils in the peripheral blood of the host. These observations suggest the presence of a non-erythropoietin regulator of erythropoiesis and a specific humoral stimulator of granulopoiesis and megakaryocytopoiesis that diffuse from the host into the DC. The effect is elicited or intensified by irradiation of the host. Study of the cell proliferation was stimulated by the introduction of tritiated thymidine (^{3}HTdR) coupled with autoradiography and classical cytology. The use of ^{3}HTdR in the study of human cell proliferation was initiated in the study of normal hemopoiesis, proliferation in multiple myeloma, and leukemia. The use of ^{3}HTdR intravenously followed by serial blood and bone marrow aspirations seriously limits the use of ^{3}HTdR because of fear of radiation hazards, discomfort of serial marrow aspirations, and the long time required for exposure, development, and study of autoradiograms. The use of diffusion chamber culture (DC) of murine hemopoietic cells and for cultures of

human bone marrow suggested that diffusion chamber technique would to a great extent simplify the study of normal and human leukemic hemopoiesis. In addition, the stimulation of growth of CFU and granulopoiesis in the irradiated host dictated the use of a larger animal in which one could grow autologous cells in DC in order to study selectively the probable humoral nature of the increased stimulatory effect of the irradiated host on growth in the DC. (HLW)

15686 (BNWL-1750(Pt.1), pp 85-87) STUDIES ON THE ROLE OF RADIATION-DERIVED FREE RADICALS IN BIOLOGICAL DAMAGE TO ERYTHROCYTES IN VITRO AND SYNTHETIC BILAYERS. Kalkwarf, D. R.; Felix, W. D. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Low concentrations of free radicals produced by gamma irradiation of D-galactose crystals were found to destroy synthetic lipid bilayers and to hemolyze porcine red blood cells. In another study, the abilities of radicals to abstract H atoms from a common substrate, glycine, were found to increase with decreasing electron density on the reactive site of the attacking radical. (auth)

15687 EFFECT OF ^{60}Co GAMMA RADIATION ON STORED BLOOD. Szotor, M.; Konopka, K.; Leyko, W. Pol. Przegl. Radiol. Med. Nukl.; 37: No. 2, 307-315(1973). (In Polish).

The effects of ^{60}Co gamma radiation on changes occurring in stored blood containing ACD fluid were studied. Irradiation was carried out in a cobalt radiation chamber. The dose was about 0.1 Mrad/hour; the thickness of the irradiated layer was 4.4 cm, and the exposure time was 3, 18, and 30 minutes corresponding to doses about 5, 30, and 50 krad. The investigations were performed 1, 7, 14, and 21 days after collection and irradiation of the blood. The phosphorus compound contents, acid-soluble fractions of erythrocytes, degree of hemolysis, and the levels of sodium and potassium in whole blood and plasma were determined. A rise in AMP and a fall in ATP were observed in the irradiated blood during storage as compared with control samples, the level of free hemoglobin and potassium rose in plasma while the sodium level rose in erythrocytes. These changes were due to damage to the mechanisms of ion transport across the erythrocyte membrane and to acceleration of the process of erythrocyte aging. (auth)

15688 REPRODUCTIVE AND INTERPHASE-DEATH AND POPULATION KINETICS OF SURVIVING HAMSTER CELLS IN VITRO, 48 HOURS FOLLOWING IRRADIATION WITH DOSES UP TO 800 RAD. Hagemann, G. (Medizinische Hochschule, Hanover). Strahlentherapie; 145: No. 4, 456-473(1973). (In German).

The frequency of reproductive and interphase-death and the population kinetics of surviving cells of the Chinese hamster were observed quantitatively in vitro for 48 hours after x-ray irradiation with doses of 200, 300, 500, and 800 rad. Dead cells, in microscopical counting, can be distinguished from surviving cells, as they are marked by Nigrosin-staining. From the periodic minima and maxima in the time-dependence of dead cells it can be concluded that there are three different lethally noxious factors: besides the reproductive and the interphase-death there exists a lethally injured cell fraction, present immediately after exposure. It is damaged in the G_2- or in the M-phase of the cell-cycle and represents the most radiosensitive fraction. The kinetics of the surviving cells show periods of 22 to 10 hours with cell-doubling times approximately half as long as those of the controls. The time of lysis of the devitalized cells lasts for a minimum of 8.4 hours and for a maximum of 13.8 hours. (GE)

15689 NOTE ON THE EFFECT OF GAMMA IRRADIATION ON PLASMODIUM KNOWLESI. Phillips, R. S.; Trigg, P. I.; Gutteridge, W. E. (Medical Research Council, London). pp 185-186 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Plasmodium knowlesi infected red cells were exposed to increasing doses of gamma irradiation and incubated in in vitro culture where the growth of the parasite was followed using morphological criteria and by measuring the rate of the incorporation of radiotracers into parasite DNA, RNA and protein. After doses of 40 kR, which renders both P. knowlesi and B. rodhaini non-infective, the former remained metabolically active in all three syntheses for a period of at least 16 h. (auth)

15690 PROTECTION OF ADULT MICE AGAINST TUMOR CHALLENGE BY IMMUNIZATION WITH IRRADIATED ADULT SKIN OR EMBRYO CELLS. Bendich, A.; Borenfreund, E.; Stonehill, E. H. (Memorial Sloan-Kettering Cancer Center, New York). J. Immunol.; 111: No. 1, 284-285(Jul 1973).

Adult mice were immunized by subcutaneous injection with x-irradiated isogenic skin or embryo cells and subsequently challenged with tumor cells from the same strain. Results indicated that embryo cells and adult skin cells contained components capable of inducing protection against tumor challenge. (HLW)

15691 DEPENDENCE OF THE TYPE AND FREQUENCY OF CHROMOSOME ABERRATION INDUCED BY GAMMA RAYS IN HUMAN BONE MARROW CELLS DURING LOCAL IRRADIATION ON THE METHOD OF HYPERTONIC PROCESSING. Pyatkin, E. K.; Suskov, I. I.; Petrova, S. A. (Inst. of Biophysics, Moscow). Lab. Delo; No. 1, 608(1973). (In Russian).

Bone marrow samples were collected from the iliac bone and the sternum of patients 24 hrs after a single therapeutic irradiation with 100, 200, 277, and 300 rad of ^{60}Co gamma rays. The samples, containing at least 4 million cells, were suspended in medium No. 199, incubated at 37°C for 1 hr, resuspended, divided into two equal portions, and centrifuged. The supernatant fluid was removed, and 7 ml of a warm 0.5% KCl solution added to one portion, while an equal volume of Hanks' solution diluted with distilled water (1:3) was added to the other portion. The cells were left in the hypotonic solutions for 10 to 15 min and then fixed and stained. In bone marrow cells treated with hypotonic KCl, the observed proportion of metaphases suitable for analysis was 60 to 70%, and a considerably larger number of aberrant cells, chromatid type aberrations (chromatid fragments and exchanges), and paired fragments were observed than after treatment with diluted Hanks' solution (only 30 to 40% of metaphases suitable for analysis), though no significant difference was detected in the frequency of chromosome-type aberrations (dicentrics and rings). The average frequency of chromatid fragments and exchanges per aberrant cell after treatment with KCl was more than twice as high as after treatment with Hanks' solution. Thus, in the latter case, a large number of aberrant metaphases, especially those with chromatid type aberrations, become unsuitable for cytological analysis. (JPRS)

15692 MUTAGENIC EFFECT OF URANIUM ON HUMAN LEUCOCYTES AND MOUSE FIBROBLASTS IN TISSUE CULTURE IN VITRO. Malenchenko, A. F.; Barkun, N. A. (Inst. of Nuclear Energy, Minsk). Dokl. Akad. Nauk BSSR; 17: No. 4, 375-377(Apr 1973). (In Russian).

The effect of uranium in cell concentrations near that determined in goiter-altered thyroid glands was evaluated in in vitro cultures of human leukocytes and the fibroblasts of mice. It was shown that during additions to the culture medium of from 0.1 to 0.5 μg/ml of uranyl nitrate (either in a culture of human leukocytes or mouse fibroblasts) polyploidal cells appeared. In human leukocyte cells dicentric chromosomes were manifest. (tr-auth)

Radiation Effects on Microorganisms

Refer also to abstracts 15679 and 17721.

15693 REPAIR DEFICIENCY IN ESCHERICHIA COLI UV-SENSITIVE MUTATOR STRAIN UVR502. Sinzinis, B. I. (Academy of Medical Sciences of USSR, Obninsk, Kaluga Region); Smirbnov, G. B.; Aenko, A. A. Biochemical and Biophysical Research Communications; 53: No. 1, 309-316(2 Jul 1973).

The effect of ultraviolet irradiation (uv) was studied in Escherichia coli mutator uv-sensitive mutant uvr502, its uvrA6 derivative, and wild-type strain. The uvr502 mutant is about 5 times more uv-sensitive than the uvr^+ isogenic strain, but 3 times less sensitive than the uvrA6 single mutant. Cells of the uvr502 mutant are unable to rejoin the fragments of parental DNA formed after uv as a result of incision. The double mutant uvrA6 uvr502 as well as the single uvrA6 mutant irradiated with uv is unable to introduce breaks into parental DNA. The extent of postreplication repair is essentially normal in the uvr502 cells. There is no significant difference between the uvr^+ and uvr502 cells in the rate and extent of uv-induced DNA degradation. (auth)

15694 VIABILITY OF BACTERIOPHAGE T_4 AFTER IRRADIATION OF ONLY THE HEAD COMPONENT OR THE TAIL COMPONENT. II. In Aqueous Suspension. Clarkson, C. E.; Dewey, D. L. (Mount Vernon Hospital, Northwood, Middlesex, Eng.). Radiat. Res.; 54: No. 3, 531-538(Jun 1973).

Amber mutants of bacteriophage T_4D were used to prepare phage head and tail components. The isolated heads and tails were purified and their response in aqueous suspension to ionizing radiation measured. The radiosensitivities were compared with that of whole bacteriophage. Both the heads and tails were inactivated exponentially. The Do (37% survival) of the tails was 1.6 krad compared with 1.2 krad for whole phage and 5.0 krad for heads. In nutrient broth the DNA containing heads were similar but slightly more sensitive to radiation than whole phage, while the protein tails were considerably more resistant. In dilute suspension however the tails were similar but slightly more resistant to radiation

than whole phage but the heads were substantially more resistant than tails or whole phage. The major lethal target for phage irradiated in dilute aqueous solution is probably located in the tail. (auth)

15695 NEW IMPETUS TO FOOD IRRADIATION. Wiesner, L. Atomwirt., Atomtech.; 18: No. 5, 254-255(1973). (In German).

From international symposium on food preservation by irradiation; Bombay, India (13 Nov 1972).

A short review is given of the IAEA/FAO symposium on food irradiation, held from Nov. 13–17, 1972 at the Trombay center near Bombay/India. Experiments for the preservation of food by irradiation are presently carried out in many other countries besides the USA and the European countries. Japan, e.g., is supporting a research project on the irradiation of some basic foodstuffs such as rice and potatoes, and onions, whereas in India experiments are being made to extend the shelf-life of fish, shrimps, and fish products by irradiation. The USA is currently investigating a new combined method for the disinfestation of papayas by means of irradiation and hot water treatment. The radiation doses applied are varied according to the food under investigation, and numerous animal experiments are carried out in these countries to prove the wholesomeness of irradiated food. The increasing concern about the use of chemical agents for the preservation of food is one of the main reasons for the great importance presently attached to food irradiation in many countries. (GE)

15696 FATE OF PYRIMIDINE DIMERS IN ULTRAVIOLET-IRRADIATED CHLAMYDOMONAS. Swinton, D. C.; Hanawalt, P. C. (Stanford Univ., CA). Photochem. Photobiol.; 17: No. 6, 361-375(Jun 1973).

A chromatographic technique was developed for the separation of ^{32}P-labeled pyrimidine nucleotide dimers of the form Py_PPy from ^{32}P-phosphate in enzymatic hydrolysates of uv-irradiated DNA. Application of this technique to ^{32}P-labeled Chlamydomonas reinhardii showed that uv irradiation of this organism induces pyrimidine dimers in both nuclear and chloroplast DNA. No evidence was found that these dimers are excised from either DNA species after several hours incubation under non-photoreactivating conditions. A function was derived to permit the pyrimidine-dimer content determined from radioactive-thymine-labeled cells to be conveniently compared with that obtained from ^{32}P-phosphate-labeled cells. (auth)

15697 POULTRY FEED RADICIDATION. I. Microbiological Aspects of Poultry Feed Irradiation. Epps, N. A.; Idziak, E. S. (McGill Univ., Quebec). Poultry Sci.; 51: 277-282(Jan 1972).

Several Salmonella spp. and Paracolobactrum arizonae were effectively incorporated in high numbers into commercially prepared poultry feeds for subsequent radiation processing. A central dose of 1.0 Mrad (1.21 to 0.75 Mrad range) effectively eliminated 3.5×10^6 to 9.2×10^7 viable cells of the various salmonellae and 9.2×10^7 cells of P. arizonae per gram of poultry feed. In all instances, storage of feed at 4°C also resulted in a decrease in the number of salmonellae, but not of P. arizonae. With the use of such Salmonella-free poultry feed, one break in the poultry-Salmonella cycle is possible. (auth)

15698 SOME EFFECTS OF IRRADIATION ON THE INFECTIVE STAGE OF THEILERIA PARVA HARVESTED FROM INFECTED TICKS. Cunningham, M. P. (East African Veterinary Research Organization, Kabete, Kenya); Brown, C. G. D.; Purnell, R. E.; Musoke, A. J.; Burridge, M. J.; Dargie, J. D. pp 145-154 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

When suspensions of Theileria parva harvested from ticks are exposed to increasing doses of radiation, it seems that increasing numbers of parasites are destroyed. However, the possibility cannot be ruled out that a degree of attenuation may be obtained within narrow limits of radiation dose and parasite concentration. (auth)

15699 ^{60}Co-IRRADIATION OF BOVINE ERYTHROCYTES INFECTED WITH BABESIA MAJOR. Purnell, R. E.; Brocklesby, D. W.; Sellwood, S. A. (Agricultural Research Council Inst. for Research on Animal Diseases, Compton, Eng.). pp 169-171 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Bovine erythrocytes infected with Babesia major were irradiated using a ^{60}Co source before being injected into splenectomized calves. A dose of 10 kR had no effect on the parasites, whereas doses of 30 and 50 kR had marked effects. The results of the subsequent challenge of the calves were difficult to interpret because of the appearance of Eperythrozoon tuomii. (auth)

15700 REVIEW OF STUDIES ON PROTECTIVE IMMUNIZATION AGAINST PIROPLASMOSIS WITH IRRADIATED PARASITIZED CELLS. Phillips, R. S. (Medical Research Council, London). pp 173-177 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Gamma radiation at dose levels of 40, 60 and 80 kR rendered Babesia rodhaini infected red cells noninfective; after doses of 10, 20 and 25 kR, a decreasing proportion of the irradiated parasites remained infective. Mice and rats have been protectively immunized against homologous challenge by injecting them with B. rodhaini infected red cells irradiated with between 40 and 80 kR. The resistance conferred shortened the patent parasitaemia and usually delayed its onset. Immunization by this technique was used for demonstrating antigenic variation in B. rodhaini. Rats were immunized with irradiated parasites of the parent population and then challenged homologously (with the parent population) or heterologously (with a putative variant population). To the homologous challenge the rats were strongly resistant but to the heterologous challenge the rats showed no resistance for the first three or four days but thereafter rapidly controlled the parasite. (auth)

15701 IMMUNIZATION OF RODENTS, DOGS, CATTLE, AND MONKEYS AGAINST AFRICAN TRYPANOSOMIASIS BY THE USE OF IRRADIATED TRYPANOSOMES. Duxbury, R. E. (Walter Reed Army Medical Center, Washington, DC); Sadun, E. H.; Anderson, J. S.; Wellde, B. T.; Muriithi, I. E.; Warui, G. M. pp 179-180 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Mice and rats were inoculated with gamma-irradiated Trypanosoma rhodesiense and after exposure to a challenging infection, 40 to 90% of the animals remained free of parasites. The mice were also protected against T. congolense. In other experiments beagles were inoculated with irradiated T. congolense; although all of the dogs died, the prepatent period was eight days in the immunized dogs compared with five days in controls. Similar experiments were conducted with T. brucei, T. congolense, and T. rhodesiense in cattle. When rhesus monkeys were immunized with irradiated T. rhodesiense, two of three monkeys remained parasite-free after challenge. (HLW)

15702 FACTORS AFFECTING THE IMMUNOGENICITY OF IRRADIATED PLASMODIUM BERGHEI PARASITIZED ERYTHROCYTES. Wellde, B. T.; Rodriguez, E. Jr.; Quigg, L.; von Doenhoff, A. (Walter Reed Army Medical Center, Washington, DC). pp 187-192 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Various procedures were found to have a detrimental effect on the establishment and maintenance of the immunity produced by irradiated parasitized cells in mice. Splenectomy both before or after immunization of mice interfered with the development and persistence of immunity. Lysis of irradiated parasitized cells in a French pressure cell (1000–20,000 lb/in^2) or by freeze thawing also prevented the establishment of detectable immunity. Increasing levels of radiation (20 kR–200 kR) applied to parasitized cells were inversely proportional to the degree of protection elicited. Gluteraldehyde fixation of irradiated parasitized cells also negated the production of any observable protective response in mice. (auth)

Radiation Effects on Plants

Refer also to abstracts 15562, 17717, 17718, and 17720.

15703 (ORO-4241-3) STUDY OF THE BIOCHEMICAL EFFECTS OF IONIZING AND NONIONIZING RADIATION ON PLANT METABOLISM DURING DEVELOPMENT. Progress Report, September 1, 1972–August 31, 1973. Klein, W. H. (Smithsonian Institution, Washington, D.C. Radiation Biology Lab.). 1973. Contract AT(40-1)-4241. 52p. Dep. NTIS $4.75.

A method for isolating and purifying phytochrome without the use of sulfhydryl protective reagents was developed. Some of the properties of this native phytochrome were examined. Its fractionation properties on G-200 Sephadex are identical to those of the large (13S; 240,000 daltons) aggregate studied previously. Dark

reversion studies indicate two kinetic populations with half-times of about fifteen and 340 min. A solar radiation monitoring station was completed and activated on Flamenco Island in Panama. Operating stations span the northern hemisphere from 71 to 9° N Lat. Analysis of data from previous years is progressing and indicates that changes in the ratios of spectral bands do occur with time of day, year, and location. A radiometer capable of monitoring uv radiation in 5 nm bands was developed, tested, and preliminarily calibrated. Preliminary results are reported on the growth and development of specific plants in relation to measured solar radiation and daylength. The influence of spectral quality on developing seeds of Arabidopsis and their subsequent germination clearly indicates that the developing seed, and not the parent plant, is the site of reception of the photostimulation. The seed can respond to light quality up to 24 hrs before full maturity. (auth)

15704 RADIOBIOLOGICAL STUDIES WITH MONOENERGETIC NEUTRONS. Hall, E. J.; Rossi, H. H.; Kellerer, A. M.; Goodman, L.; Marino, S. (Columbia Univ., NY). Radiat. Res.; 54: No. 3, 431-443(Jun 1973).

The Radiological Research Accelerator Facility (RARAF) has the capability of producing essentially monoenergetic neutron beams, ranging in energy from 15.4 MeV down to 220 keV. In addition, two lower energy neutron beams are available, which consist of a wide spectrum of energies and are described as the 110 and 60 keV spectra. Seedlings of Vicia faba were used to measure the oxygen enhancement ratio (OER) and the relative biological effectivensss (RBE) of each of these neutron beams. The OER decreases as the neutron energy is reduced between 15.4 MeV and 220 keV, but does not appear to decrease further for lower energy neutrons. RBE increases as the neutron energy is reduced from 15.4 MeV to 440 keV; the curve then goes through a maximum at around 350 keV, and for lower energies the RBE falls again. (auth)

15705 EFFECTS OF VARIOUS DOSES OF GAMMA IRRADIATION ON THE GROWTH OF PEA AND ON ITS PHOSPHATE AND SULPHUR METABOLISM. Frank, J.; Tolnay, L. Acta Agron. Acad. Sci. Hung.; 21: No. 1-2, 147-152(1972).

In IP/1 pea plants irradiated with 0.5, 1.0, 5.0, 10.0, and 20.0 kR doses the extent of inorganic $^{32}PO_4$ uptake and incorporation in organic fractions increase in the third week following germination. Organic compounds of low molecular weight are exceptions when using irradiation with a dose of 5.0 kR. Stimulation has a small-dose and a large-dose maximum. As regards incorporation of $^{35}SO_4$ a similar tendency is shown with the difference that the large-dose maximum appears with 10.0 kR applied, while with a dose of 20.0 kR it decreases. On the other hand, irradiation (except for the 0.5 kR treatment) has an inhibiting effect on the morphogenesis of plants; here too, a small-dose (1.0 kR) and a large-dose (20.0 kR) maximum of stem length can be observed. (auth)

15706 IN VITRO CULTURE OF COTTON MICROSPORES IN RELATION TO RADIOBIOLOGICAL INVESTIGATIONS. Bahavandoss, M.; Madhavamenon, P. (ACRI, Coimbatore, India). J. Palynol.; 6: 84-86(1970).

The assessment of sensitivity of the cotton microspores to x rays was made by culturing the pollen of a diploid cultivar K6 (G. arboreum race indicum) and a tetraploid cultivar PRS. 72 (G. hirsutum) in 40% chemically pure sucrose solution after irradiation of pollen at different doses. It was concluded that the lethal doses for the pollen of the diploid species would be around 400 R and that for the tetraploid species is slightly higher than that value. The pollen germination in sucrose solution was inferred to be more reliable as an index for viability than vital staining, because of the deleterious effects on pollen tube growth resulting from effects of irradiation prior to germination. Such effects could be detected only during the course of elongation of the pollen tube. (Indian Sci. Abst.)

15707 GENETIC ANALYSIS OF DEVELOPMENTAL STAGES OF THE CELLULAR SLIME MOLD DICTYOSTELIUM PURPUREUM. Yamada, T. (Tokyo Metropolitan Isotope Research Inst.); Yanagisawa, K. O.; Ono, H.; Yanagisawa, K. Proc. Nat. Acad. Sci. U.S.A.; 70: No. 7, 2003-2005(Jul 1973).

Seventy-one mutants of Dictyostelium purpureum induced by γ radiation or nitrosoguanidine, unable to carry out normal development, were isolated. These mutants fall into three phenotypic classes. The mutants of the first class do not aggregate. Those of the second class develop a little further and form conical aggregates. The mutants of the third class progress still further, and the conical aggregates are transformed into finger-shaped masses, but no fruiting bodies are formed. Mutants of each class were able to form fruiting bodies when mixed with mutants of other classes. Pairs of mutants belonging to the same class, however, never responded synergistically. This result indicates the presence of three distinct developmental stages in the process of the fruiting-body formation. Experiments with actinomycin D suggested that genes controlling the developmental process of D. purpureum were divided into three groups, which were identical to those identified by the analysis of synergism. (auth)

15708 RADIOSENSITIVITY OF SEEDS IN THE LIGHT OF THE LAW OF THE HOMOLOGOUS SERIES IN HEREDITARY VARIABILITY. Preobrazhenskaya, E. I. (Agrophysical Scientific-Research Inst., Leningrad). Dokl. Akad. Nauk SSSR; 209: No. 6, 1470-1472(21 Apr 1973). (In Russian).

Data were obtained on the radiation sensitivity of seeds of four species of the section Vicieae of the bean family: Cicer arietinum, Faba vulgaris, Lathyrus sativus, and Pisum sativum, by irradiating their seeds with ^{60}Co gamma rays in various doses. LD_{50} and LD_{100} were measured. The data indicated that closely related forms of plants manifested similar sensitivities to ionizing radiation. Certain regularities were observed and are discussed. (KSW)

15709 MECHANISM OF RADIATION SENSITIVITY OF SEEDS WITH HIGH MOISTURE CONTENT. Savin, V. N.; Arkhipov, M. V. (Agrophysical Scientific-Research Inst., Leningrad). Dokl. Akad. Nauk SSSR; 210: No. 1, 218-220(1 May 1973). (In Russian).

The relative roles of the degree of hydration and the state of the DNA in the radiation sensitivity of seeds with a high moisture content were studied. Barley seeds, dry and moistened in Petri dishes for 18 hr, were irradiated with a ^{60}Co source at 2.5, 5, 10, and 20 kR at a rate of 500 R/min and then allowed to germinate at 22°C. A decrease in the DNA in the rootlets was noted for the dry seeds only after 10 kR, whereas the wet seed DNA was reduced in the case of only 2.5 kR of radiation. Thus, increased sensitivity to radiation characterized seeds with a high moisture content. (KSW)

Radiation Effects on Animals

Man

Refer also to abstracts 15321, 15475, 15512, and 16160.

15710 (AD-749384) CALCULATIONS OF DOSE RATES ARISING FROM RADIOACTIVE FALLOUT UPON AN URBAN ENVIRONMENT. Final Report, August 1969—June 1972. Cohen, M. O. (Mathematical Applications Group, Inc., Elmsford, N. Y. (USA)). Jun 1972. Contract DAHC20-70-C-0221. 75p. (MR-7027). NTIS.

A series of computer calculations were performed to determine exposure rates which would be produced by radioactive fallout deposited in typical urban areas. First, a uniform fallout distribution was assumed and the perturbations to readings in the streets, caused by the presence of large neighboring structures, were determined. Next, the effects of various errors, inherent in the monitoring procedures, were examined. Finally, the magnitude of local hot spots caused by the distribution of fallout as might occur due to the action of the wind or rain, was assessed. (auth)

15711 (LA-5266-MS) RECOMMENDATIONS FOR IMPLEMENTING RADIOTHERAPY WITH NEGATIVE PIONS AT LAMPF. Richman, C.; Groce, D. E. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 81p. Dep. NTIS $5.45.

Recommendations concerning the implementation of radiotherapy with negative pions are presented. The recommendations are derived from the activities of various subcommittees on: beam line and the facility; physical and biological dosimetry; cellular radiobiology; whole animal radiation biology and pathology; radiation therapy; and isotope development and diagnostic applications. The report also presents drawings of the biomedical facility, final beam line design, drawings of the final beamline, organizational meeting of the subcommittee on tumor localization and treatment simulation (with recommendations), and the outlook for the work. (ERB)

15712 (ORNL-TR-2628) "ESDORA" COMPUTER CODE PROGRAM FOR AN ESTIMATE OF THE RADIATION DOSE IN THE EVALUATION AND RISKS FOR NUCLEAR POWER PLANTS AND RADIOACTIVE FACILITIES. Diaz de la Cruz, F. Translated from a Spanish Report. 80p. Dep. NTIS $6.00.

The selection of a site for a nuclear plant must be accompanied, among other things, by an evaluation of the damage which such a plant might cause in the area as a consequence of fission products, or radioactive products in general, which might accidentally be emitted into the atmosphere. A computer program was developed as an analytical tool to evaluate the risks incurred should an explosive type of accident occur in a nuclear facility. In special cases the program can calculate this damage with normal operation of the facility. This program, called ESDORA (EStimacion de

DOsis RAdiologicas) (estimate of radiation doses) estimates the damage produced by the continuous or instantaneous escape of fission products into the atmosphere. It was programmed in FORTRAN IV for the IBM 7090 computer and is divided into 4 subroutines. ESD 1 generates an inventory of fission products according to the operating process (or burnup) of the fuel of the facility; ESD 2 determines the quantity of fission products emitted to the atmosphere through the stack or the containment building, taking into account the technical safety measures employed; ESD 3 calculates the integrated doses of the radioactive cloud, well as the ground-level contamination due to fallout of the fission products, with consideration of meteorological conditions; and ESD 4 estimates the external β and γ doses resulting from submersion in the radioactive cloud, as well as the internal doses received by the various organs of the human body following inhalation of radioisotopes. The mathematical models used, the simplifying assumptions adopted, the data used, lists and flowsheets of the specific subroutines, as well as the necessary instructions for their use are presented. (auth)

15713 RADIOGRAPHIC APPEARANCE OF THE CHEST FOLLOWING EXTENDED FIELD RADIATION THERAPY FOR HODGKIN'S DISEASE. A Consideration of Time-Dose Relationships. Libshitz, H. I.; Brosof, A. B.; Southard, M. E. (Thomas Jefferson University Hospital, Philadelphia). Cancer; 32: No. 1, 206-215 (Jul 1973).

Changes in the thorax following extended field radiation therapy for Hodgkin's disease are reviewed retrospectively. All patients were treated with cobalt-60. Strict criteria were established to exclude patients with previous radiation therapy, chemotherapy, evidence of pulmonary parenchymal disease, or inadequate radiographic follow-up. Nineteen of 20 patients showed changes; 13 showed evidence of radiation pneumonitis. Nineteen showed evidence of radiation fibrosis or loss of volume. Radiation pneumonitis appeared more frequently at 8 to 12 weeks following the completion of therapy. Radiation fibrosis was generally established by the ninth to twelth month following the completion of therapy. Two cases of radiation pericarditis were seen. There is a time-dose relationship of the pulmonary parenchymal radiation changes that needs to be further defined. (auth)

15714 LESIONS OF BONE TISSUES FOLLOWING MAMMARY CARCINOMA TREATED BY RADIOTHERAPY. Guzecki, A. Pol. Przegl. Radiol. Med. Nukl.; 37: No. 2, 277-281(1973). (In Polish).

On the basis of 661 patients with mammary carcinoma treated by radiotherapy and followed up for longer than 12 months a retrospective evaluation of the frequency of bone lesions was carried out. Radioinduced lesions of ribs and clavicle were observed in 90 patients (13.6%); however, they were notably absent in cases treated by radiotherapy according to the Manchester technique with tangential direction of the radiation beam in relation to the chest wall. Radioinduced lesions of bones were statistically significantly more frequent in women aged over 61 years. The radiological appearance of radioinduced lesions of ribs and clavicle showed characteristic atrophy of bone structure and transverse fractures but they were usually asymptomatic. (auth)

15715 HAZARDS OF RADIOTHERAPY IN DERMATOLOGY. Touraine, R.; Revuz, J.; Larregue, M. (Hopital Henri-Mondor, Creteil, France). Rev. Prat.; 22: No. 28, 3851-3859(1 Nov 1972). (In French).

Chronic dermatites, appearing late with their possible course toward necrosis and cancerization, have not become exceptional yet in spite of progress in irradiating techniques. Emphasis should be laid on the frequency of dermatitis following irradiation of benign skin lesions, especially warts and angiomas. The only treatment of chronic radiodermatitis is surgery. (auth)

15716 BONE MARROW AND RADIOTHERAPY. Laugier, A.; Lavaurs, A. Rev. Prat.; 22: No. 28, 3861-3870(1 Nov 1972). (In French).

Irradiation of bone marrow results in cellular depopulation. Blood cytopenia is observed after variable time according to the type of cells considered. It is proportional to the radiation dose and to the relative fraction of bone marrow irradiated. Blood recovery occurs by local restoration, the repopulation starting in nonirradiated areas with compensatory hypertrophy. Very extended medullary irradiations are possible in man subject to taking into account the limited numbers (50,000 platelets and 2,000 leukocytes) and avoiding simultaneous associations with antimitotic chemotherapies. (tr-auth)

15717 COLORECTAL COMPLICATIONS OF PELVIC IRRADIATIONS. Malafosse, M. (Hopital Saint-Antoine, Paris). Rev. Prat.; 22: No. 11, 1867-1877(11 Apr 1972). (In French).

Having often cured the malignant condition that motivated its use, radiotherapy often leaves behind colorectal sequelae of various severity. Only secondary and late actinic lesions may occasionally warrant surgical treatment. Their frequency is low and they occur more easily under the influence of particular causal factors. Intestinal hemorrhage is the most common clinical symptom and the final result may be colon or rectum stenosis. Diagnosis of these actinic stenoses may be debatable, especially when the initial malignant growth reappears. Surgical treatment should be undertaken with the utmost reserve and only after patient and protracted medical treatment. Surgery on the previously irradiated patient is a great source of difficulties and disappointments: parietal complications, necrosis, intestinal perforations and fistulas, and urinary fistulas. The techniques most commonly used are colostomies but they are often insufficient and have to be supplemented in a number of cases by colic or rectal exersis. (auth)

15718 HAZARDS IN RADIOTHERAPY OF THE LIMBS. Guerin, R. A. (Groupe Hospitalier Pitie, Paris). Rev. Prat.; 22: No. 28, 3839-3848(1 Nov 1972). (In French).

The risks of radiotherapy of the limbs do exist but they should always be avoided when the purpose of irradiation is anti-inflammatory, analgesic, decompressive, or palliative. The accidents observed are in most cases due to technical errors or mistaken therapeutic indications. With a careful technique curative treatment of warts is possible by x ray. Curative radiotherapy against cancer provokes generally reversible immediate incidents. Late radiolesions may however appear long after radiotherapy. The patient should always be told about those possible dystrophic or functional sequellae, which should remain compatible with a normal social activity. The treatment of reversible early incidents is medical; late radiolesions should be entrusted to surgeons experienced in grafting techniques. The best treatment remains prevention: the probability of hazards should always be born in mind when an indication of radiotherapy is discussed. All guarantees of focusing, dosimetry, and surveillance should then be fulfilled. (auth)

15719 HAZARDS OF RADIOTHERAPY OF THE THORAX. Raynal, M. Rev. Prat.; 22: No. 28, 3817-3826(1 Nov 1972). (In French).

The efficiency of radiotherapy in thorax carcinology especially in the curatively intended treatment of breast cancer or Hodgkin's disease is no longer debatable. This necessarily agressive weapon is not however without risks and requires great care in the choice of indications and technical procedures. Among these risks some are minor complications such as pectoral sclerosis or brachial oedema but other are major accidents: esthetic damage, radiotherapeutic lung or paralysis. The probability of such accidents is fortunately low and should not decrease the value of the method that is, however, too recent to be fully established. (auth)

15720 RADIOTHERAPY AND THE IMMUNE RESPONSE IN CANCER OF THE LUNG. Braeman, J.; Deeley, T. J. (Velindre Hospital, Cardiff, Wales). Brit. J. Radiol.; 46: No. 546, 446-449 (Jun 1973).

The cellular immunity of 64 patients with an histologically proved carcinoma of the lung was investigated using the technique of lymphocyte transformation to phytohaemagglutinin (PHA). The patients were treated by radical radiotherapy and were tested before treatment, at the end of treatment, and at intervals during follow-up. The average response of the patients before treatment was lower than that of the controls. Transformation was depressed by radiotherapy. The lymphocyte transformation response before treatment was not related to survival of the patient after treatment, but there is a suggestion that the degree of depression during radiotherapy is related to survival. (auth)

15721 IMMUNOSUPPRESSIVE CONSEQUENCES OF RADIOTHERAPY AND CHEMOTHERAPY IN PATIENTS WITH ACUTE LYMPHOBLASTIC LEUKAEMIA. Campbell, A. C.; Hersey, P.; MacLennan, I. C. M.; Kay, H. E. M.; Pike, M. C. (Radcliffe Infirmary, Oxford). Brit. Med. J.; 2: No. 5863, 385-388(19 May 1973).

Assays of lymphocyte subpopulations and function were performed on patients with acute lymphoblastic leukemia still in remission after 18 months' treatment. The patients were subjects of a trial of the value of craniospinal irradiation in the third month of treatment in preventing central nervous system relapse. Effects of both irradiation and chemotherapy were observed. Lymphopenia was much more marked in those patients who had received irradiation over a year previously. Assays of response to phytohemagglutinin (P.H.A.) and staining for surface immunoglobulin indicated that this difference was due to a deficiency in thymus-dependent lymphocytes in the irradiated children. Chemotherapy had a particularly marked depressant effect on lymphocytes with antibody-dependent cytotoxic activity and a proportion of PHA-responsive cells were also depressed. It is suggested that it may be relevant

that four of the patients depleted of thymus-dependent lymphocytes by radiation died of infection during remission, while none of those treated with chemotherapy alone died in remission. (auth)

15722 MULTIPLE FOCI OF ATYPICAL EPITHELIAL HYPERPLASIA (TUMOURLETS) IN IRRADIATED HUMAN LUNGS. Talerman, A. (Rotterdamsch Radio-therapeutisch Institut). Brit. J. Radiol.; 46: No. 546, 464-466(Jun 1973).

A case report and post-mortem findings are presented for a 37 yr old man who had been treated surgically for malignant teratoma of the testis, and subsequently by radiotherapy for multiple pulmonary metastases. It is pointed out that the finding of tumorlets or foci of atypical epithelial hyperplasia in lungs affected by severe pulmonary pneumonitis, less than 4 months after a course of radiotherapy, in a patient without previous history of lung disease, suggests that their formation was associated with the treatment, and that the lesions are not related to the genesis of pulmonary carcinoma or bronchial adenoma. Emphasis is laid on the importance of distinguishing these atypical lesions from small metastase deposits and other lesions such as bronchial adenomas and small pulmonary chemodectomas. (UK)

15723 MEASUREMENTS OF SURFACE DOSE FROM EXPOSURES WITH SPECIAL MAMMOGRAPHY APPARATUS. Heuss, K.; Hoeffken, W. (Allgemeinen Ortskrankenkasse, Cologne). Fortschr. Geb. Roentgenstr. Nuklearmed.; 117: No. 6, 669-673(Dec 1972). (In German).

Surface dose was determined by an indirect method for four commercially available mammography sets. Considerable variations between different types of apparatus were found. The distribution of radiation dose was determined in 103 patients. Average surface dose per exposure was between 3.9 and 11.7 R. (auth)

15724 POSTRADIATION DAMAGE OF THE TEMPORAL LOBE FOLLOWING HIGH-ENERGY IRRADIATION OF MALIGNANCIES OF THE EPIPHARYNX. Krayenbuehl, H.; Ruettner, J. R. (Univ., Zurich). Schweiz. Med. Wochensch.; 103: No. 7, 225-231(17 Feb 1973). (In German).

Two cases of delayed radiation necrosis of the temporal lobe as a result of irradiation of carcinomas of the epipharynx are presented and the morphological changes in the brain are discussed. The postradiation brain necrosis in these two cases is similar to those described by most observers. The widespread degenerative changes near the blood vessels and in their lumen are most striking. The selective vulnerability of the white matter is probably a function of its metabolism, and immunological processes may also be involved in the pathogenetic mechanisms. The gradual deterioration of the patient's clinical condition is related to signs of increased intracranial pressure. Diagnosis is made by cerebral angiography and the treatment of choice is surgery with complete removal of the brain necrosis. The immediate operative result is favorable. (auth)

15725 DOSAGE IN PANORAMIC RADIOGRAPHY. Sonnabend, E. (Univ., Munich). Deut. Zahnaertztl. Z.; 27: No. 12, 984-992 (Dec 1972). (In German).

Dosage in the various panorama x-ray exposures is reported. This is compared in the skin, mucous membrane, and gonadal areas with the dose for the previous intraoral radiostat exposures. It is shown that the skin surface dose, and in particular the gonadal dose in panorama x-ray exposures must be judged to be considerably more favorable than the earlier radiostat exposure. Radiation stress of a small area of mucous membrane is, however, relatively high when the panorama magnification exposure is applied. The chamber dosimeters formerly used are compared critically with the thermoluminescence dosimeters now in use. The latter are decidedly preferable for the range of measurements discussed. Radiation protection for the patient is not unessential in all panorama x-ray exposures, and proper anti-radiation measures by the dentist and his assistant are indispensable. (auth)

15726 ELIMINATION OF SEQUESTRUM AND HEALING OF OSTEORADIONECROSIS OF THE MANDIBLE AFTER HYPERBARIC OXYGEN THERAPY: REPORT OF A CASE. Mainous, E. G. (Naval Hospital, Long Beach CA); Boyne, P. J.; Hart, G. B. J. Oral Surg.; 31: 336-339(May 1973).

Hyperbaric oxygen therapy was effective in decreasing the healing time in cases of intractable postirradiation osteomyelitis. Four cases were treated successfully by this procedure. One of these cases is reported in detail in which all suppuration ceased, intraoral sinus tracts closed, and rapid resorption of a large sequestrum occurred after 120 hours of hyperbaric oxygenation at 2 atmospheres absolute, 100% oxygen. (auth)

15727 SHOULD MEDICAL RADIATION EXPOSURE BE RECORDED FOR RADIATION WORKERS. Eason, C. F.; Brooks, B. G. (Atomic Energy Commission, Washington, DC). Nucl. Safety; 14: No. 3, 220-225(1973).

Vertebrates

15728 (BNWL-1750(Pt.1), pp 11-12) CALIFORNIUM-252 STUDIES IN MINIATURE SWINE. Sullivan, M. F.; Beamer, J. L.; Case, A. C. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The amount of Na activation was determined in miniature swine exposed to ^{252}Cf neutrons. It was found that a maximum of 2 nCi per ml was excreted in the urine following exposures that delivered from 2500 to 4000 rads to a point 2 cm lateral to tandem applicators containing four 12-μg ^{252}Cf sources. The amount excreted was markedly influenced by the health of the animal; an animal in poor health retained Na regardless of the length of exposure to a neutron source. The RBE for ^{252}Cf neutrons was being determined in rats using changes in morphology and function of the G.I. tract as end points and comparing whole-body exposures to ^{226}Ra γ and ^{252}Cf. (CH)

15729 (BNWL-1750(Pt.1), pp 67-69) BIOLOGICAL EFFECTS OF INTRACORPOREAL ^{238}Pu HEAT SOURCES IN SWINE. Gillis, M. F.; Decker, J. R.; Winegardner, W. K.; Karagianes, M. T.; Cross, F. T. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Progress is reported in the development of a mechanical heart using a ^{238}Pu heat source. Earlier work established surgical methods for fixing heavy implants in the dorsal thorax of miniature swine, developed telemetry circuitry for monitoring internal heat exchanger temperatures in free-ranging animals, and perfected apparatus and surgical procedures required for the cooling of a source-containing heat exchanger and for its rapid transfer to the thoracic aorta. Two surgical control animals were implanted with thoracic heat exchangers in their descending aorta, containing lead slugs to mimic the anticipated mass of the 50-W ^{238}Pu source. One source has now been received, and its incorporation in the thoracic heat exchanger preparation will take place soon. Telemetry performance was refined and trials of circuitry performance were carried out in the body cavities of animals killed for other reasons. (CH)

15730 (BNWL-1750(Pt.1), pp 69-70) DEVELOPMENT AND EVALUATION OF BLOOD IRRADIATORS IN DOGS: ^{125}I, ^{147}Pm, ^{238}Pu, ^{90}Sr, ^{204}Tl, AND ^{90}Y. Hungate, F. P.; Griffin, B. I.; Jarrett, J. H.; Gillis, M. F. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

A ^{204}Tl blood irradiator has now been implanted in the thoracic aorta of a beagle dog for more than a year. The initial dose to dog blood was slightly more than 10 rads per day. This dog has shown no change in either small or large lymphocyte levels nor change in migration of peripheral blood cells when challenged in vitro with an appropriate antigen, and skin allograft rejection time was not prolonged. Several other new types of irradiators were developed using ^{125}I, ^{147}Pm, ^{238}Pu, ^{90}Sr, or ^{90}Y as sources. Preliminary testing results are reported. (CH)

15731 (COO-1332-95) EFFECTS OF IONIZING RADIATION AND OTHER ENVIRONMENTAL FACTORS ON BREEDING BEHAVIOR, ACTIVITY PATTERNS, AND MOVEMENT OF SELECTED VERTEBRATES. Progress Report, July 1, 1972-June 30, 1973. Tester, J. R. (Minnesota Univ., Minneapolis. James Ford Bell Museum of Natural History). Jul 1973. Contract AT(11-1)-1332. 58p. Dep. NTIS $5.00.

The effects of acute exposure to 300 R γ radiation on the behavior and survival of wild mammals living under natural conditions were studied. Data are presented on free-ranging raccoons, snowshoe hares, and striped skunks. No changes in behavioral patterns were observed in the irradiated animals. Mortality during the 30-day post-irradiation period was attributed to natural predators rather than radiation injuries, with the exception of juvenile raccoons, who appeared to be radiosensitive. No effects of radiation on survival time were observed in hares or skunks, or in raccoons that had survived for 30 days following exposure as juveniles. (CH)

15732 (COO-3097-6) EFFECT OF RADIATION ON NORMAL HEMATOPOIESIS AND ON VIRAL INDUCED CANCERS OF THE HEMATOPOIETIC SYSTEM. Three Year Technical Progress Report, June 1, 1970-April 14, 1973. OKunewick, J. P. (Allegheny General Hospital, Pittsburgh, Pa. (USA). Cellular and Radiation Biology Labs.). 1973. Contract AT(11-1)-3097. 48p. Dep. NTIS $4.50.

Studies were carried out comparing the injury and recovery of various interrelated elements of the erythropoietic system after

sublethal (200 R) exposure to x rays. In the peripheral blood a distinct fall and an early (6-7 day) abortive rise in reticulocytes and newly formed hemoglobin could be seen, followed by a second drop and final recovery to normal levels at 2-3 weeks after exposure. A similar drop in total nucleated cells could be seen in both femoral marrow and spleen. However, splenic recovery was slow, whereas recovery to normal nucleated cell levels occurred by 5 days in the marrow. Transplantable marrow colony-forming units also showed delayed recovery, reaching normal proportions at 16 days with no abortive rise. Total blood and plasma volumes showed only minimal changes, although there was a significant drop in hematocrit. Levels of erythropoietic stimulating factors (ESF) showed a slight increase consistent with the fall in hematocrit, but no large fluctuations which could be easily correlated with the variations in reticulocyte production. Studies carried out on induction of leukemia in the SJL/J mouse demonstrated that one of the prime effects of the disease is to significantly increase the resistance of the leukemic mouse to a normally lethal dose x ray. Investigation into the etiology of the disease showed that the disease also induced a very large increase in the number of pluripotent colony-forming units in the spleen. Investigation of the growth in supralethally irradiated mice of colonies obtained from these cells showed them to be insensitive to the normal homeostatic regulators which govern total organ size. Further, on a cell for cell basis they were less efficient than the normal in both their erythropoietic ability and their ability to successfully seed in the spleen of a normal, lethally irradiated, recipient. Other etiological studies showed that the nature of the hemopoietic tissue environment (marrow vs. spleen) exerts a significant effect on the ability of the virus to infect a potential target cell or on the expression of the virus action on that cell. Finally, experiments aimed at utilizing radiation in the therapy of viral leukemia have shown some promise, suggesting that in combination with other agents radiotherapy may be an effective tool for the treatment of viral cancers. (auth)

15733 (COO-3267-3) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MICE. Progress Report, June 1, 1972-May 31, 1973. Roderick, T. H. (Jackson Lab., Bar Harbor, Maine). 31 May 1973. Contract AT(11-1)-3267. 28p. Dep. NTIS $3.50.

Progress is reported on studies on radioinduced chromosomal inversions in mice with regard to the following: detection of inversions; screening for new inversions; mutagenic effects of EMS, TEM, flupromazine, and trifluprom azine; homozygosity and linkage of inversions; cytology; use of inversions in balanced lethal test system; and studies on Robertsonian metacentric chromosomes in the Tobacco mouse. (HLW)

15734 (COO-3492-13) INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS. Final Report. DiStefano, V. (Rochester Univ., N. Y.). 1971. Contract AT(30-1)-3492. 16p. Dep. NTIS $3.00.

Numerous agents related to aminoethylisothiourea (AET) were prepared and tested both for their ability to protect against radiation in mice and for their pharmacological effects in cats and mice. The agent with fewest side effects but that still retained antiradiation activity was N'-aminopropylisothiourea (APMT). Studies were also undertaken to determine the mechanism of toxicity of the parent compound, AET. Among its side effects, AET was shown to lower cardiac catecholamine levels in cats and mice. The mechanism of this lowering was attributed to the inactivation of dopamine-β-hydroxylase (DBH), the enzyme that transforms dopamine to norepinephrine (NE) during catecholamine biosynthesis. Tyrosine hydroxylase (TOH), the enzyme responsible for the first step in catecholamine biosynthesis, after six days of AET administration was also depressed. However, this event did not correlate temporally with cardiac NE depletion. Ouabain administration partially restored the NE levels in depleted hearts. Hearts of cats treated with AET demonstrated mitochondrial changes on electron microscopic examination. These changes took the form of various stages of degeneration of the cristae and appeared to be reversible. The toxicity and metabolism of dimethyl sulfoxide (DMSO) was also studied. DMSO is reduced to dimethylsulfide (DMS) by an interaction with endogenous sulfhydryl compounds rather than during metabolizing systems. High concentrations of DMSO given intravenously produced massive hemolysis. A highly sensitive method for the determination of catecholamines was devised. Improved gel filtration methods were also developed for the separation of small molecules (biogenic amines). (auth)

15735 (RLO-2227-T-8-4) RADIOECOLOGICAL STUDIES OF AMPHIBIANS. Annual Progress Report, June 16, 1972-June 15, 1973. Willis, D. L. (Oregon State Univ., Corvallis). 1973. Contract AT(45-1)-2227. 46p. Dep. NTIS $4.50.

The metabolism of ^{60}Co was studied in the newts, Taricha granulosa and Notophthalmus viridescens. Graphs are presented to show ^{60}Co uptake following chronic exposure and whole body retention following single exposures. A table is presented to show distribution in the blood, skin, spleen, and other organs following a single intraperitoneal injection. The radioecological significance of the results is discussed. Zinc-65 metabolism was studied in the skin of frogs (Rana pipiens) and newts (Taricha granulosa). It was found that the activity was directly associated with malanin pigments. The uptake, distribution, and retention of ^{203}Hg and ^{65}Zn were studied in freshwater molluscs, Margaritifera Lampsilis radiata, and Anodonta nuttalliana. When newts (Taricha granulosa) were exposed to ionizing radiation and oil, a synergistic effect was found on the liver, spleen, skin, and survival time. Embryos of frogs (Rana pretiosa) were immersed in ^{134}Cs and effects on development were studied. (HLW)

15736 (UR-3055-7) RECOVERY OF SPERMATOGONIA IN RAT TESTES AFTER DEPLETION BY SINGLE AND FRACTIONATED X-RAY EXPOSURES. Timberlake, N. G. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1973. 209p. Dep. NTIS $12.50.

Thesis.

The extent of radiation damage and the mechanisms of recovery of seminiferous epithelium of rats after depletion of this epithelium by single and fractionated x ray exposures were studied histologically following either single exposure doses of 900 R, 1200 R, 1500 R, 1800 R, or 2100 R, or fractionated exposures of 6 R, 10 R, 20 R, or 40 R/day up to a total accumulated dose of 1200 R. Each animal was killed and examined grossly and histologically at a particular time up to 6 months post-irradiation. All exposure groups showed marked depression of sperm count, although no relationship between size of dose and degree of depression could be discerned at times of observation chosen. No significant differences between single exposure dosage groups were noted in the response of the testis weights at varying times after irradiation. Fractionated exposures of 20 R and 40 R/day were twice as efficient as either 6 R or 10 R/day, or as 1200 R given as a single exposure in reducing the numbers of spermatogonia. In terms of maximum recovery as measured at 6 months post-irradiation, a single exposure dose of 1200 R was ten times as efficient in the reduction of prespermatocytes as 6 R and 10 R/day, but slightly less efficient than 20 R and 40 R/day. Possible sources for regenerative processes include the existence of undifferentiated spindle-shaped cells within the basement membrane of the seminiferous tubules which are capable of functioning when stimulated by depletion of type-A spermatogonia to undergo differentiation to form type-A spermatogonia-like cells which subsequently move into the tubule as functioning type-A spermatogonia. (CH)

15737 BEHAVIORAL EFFECTS OF NEONATAL IRRADIATION OF THE CEREBELLUM. II. Quantitative Studies in Young-Adult and Adult Rats. Wallace, R. B.; Altman, J. (Univ. of Hartford, West Hartford, CT). Develop. Psychobiol.; 2: No. 4, 266-272(1970).

Young-adult and adult rats whose cerebellum was focally irradiated with a variable number of daily doses of 200 R x ray during infancy were tested for spontaneous locomotion, in activity wheels, for muscular strength, in a weight-pulling apparatus, and, for skill in coordination, in a rope-climbing apparatus. Spontaneous activity declined as a function of number of daily irradiations; the interaction of treatment, age, and prior experience was also investigated. Weight pulling capacity, as determined by running time in an alleyway, was not affected by irradiation with 1 to 4 $\times$ 200 R with loads equaling the rats' own body weights. Ease of rope climbing was inversely related to the number of daily irradiations in terms of climbing time, number of shocks received, falls off the rope, and other criteria. (auth)

15738 EFFECT OF X-IRRADIATION AND FASTING ON HEPATOTOXICITY OF CARBON TETRACHLORIDE IN RATS. Highman, B.; Cyr, W. H.; Streett, R. P. Jr. (Armed Forces Inst. of Pathology, Washington, DC). Radiat. Res.; 54: No. 3, 444-452(Jun 1973).

Groups of rats, given 2.5 ml/kg CCl_4 subcutaneously or 1.5 ml/kg of 50% CCl_4 in olive oil perorally developed in 24 hours hepatic centrolobular necrosis and increased serum levels of glutamic oxalacetic and pyruvic transaminases, lactic dehydrogenase and aldolase. These changes were greater after a peroral dose. A whole-body exposure to 550 R 24 hours before CCl_4 administration decreased food consumption and augmented the changes in nonfasted rats. A 24-hour fast, begun 16 hours before CCl_4 administration, further aggravated changes in both irradiated and nonirradiated groups, and group differences were

minor. The effect of irradiation on CCl_4 toxicity seemed due largely to reduced food consumption on the second day. However, augmentation of tissue and serum enzyme changes occurred even when the irradiation was given 11 days before CCl_4 and food consumption had returned to normal. This suggests that occult damage to the liver or residual damage to the intestine or other organs directly or indirectly may contribute to lessening the ability of the liver to detoxify certain compounds. These findings suggest caution in prescribing restricted diets and potentially hepatotoxic drugs to radiotherapy patients. (auth)

15739 EFFECT OF DOSE RATE UPON REPRODUCTIVE PERFORMANCE OF WHITE LEGHORN HENS AND THEIR PROGENY. Mraz, F. R.; Woody, M. C. (Univ. of Tennessee, Oak Ridge). Radiat. Res.; 54: No. 3, 549-555(Jun 1973).

Groups of 30 White Leghorn hens were exposed to 800 R (^{60}Co) at each of the following dose rates: 1, 5, 25, or 42 R/min and compared with 30 hens kept as controls. Reproductive performance was recorded in these hens and their progeny from eggs hatched at varying times after irradiation. Half the surviving hens in each group were exposed to 800 R (25 R/min) 159 days after the first irradiation and egg production recorded for 8 weeks. Egg production was reduced by dose rates varying from 5 to 42 R/min during the first 5 to 6 weeks after irradiation. Hatchability of the eggs was reduced during the first 14 days after irradiation at 25 and 42 R/min, but the reproductive performance of the progeny was not altered. The 42 R/min rate given in the first irradiation seemed to have a residual effect on egg production over an 8-week period after the second exposure of 800 R at 25 R/min. (auth)

15740 USE OF THE WOUND RESPONSE TO DEMONSTRATE LATENT RADIATION DAMAGE AND RECOVERY IN X-IRRADIATED INTERMITOTIC CELLS OF THE RAT LENS EPITHELIUM. Lindgren, A. L.; Riley, E. F. (Univ. of Iowa, Iowa City). Radiat. Res.; 54: No. 3, 411-430(Jun 1973).

The ability of irradiated intermitotic cells of the rat lens epithelium to respond to a mitogenic stimulus produced by wounding was used to reveal latent radiation damage and to measure cellular recovery. Only the eyes were x-irradiated with 1000 rads. Whole mounts of lens epithelia, ^{3}H-TdR cell labeling, and autoradiographs were utilized to evaluate the response. In unirradiated epithelia, a wave of DNA synthesis began 12 to 14 hr after wounding and a wave of mitosis began 10 hr later. Irradiation 1 hr before or after wounding delayed and suppressed the waves of DNA synthesis and mitosis. Some recovery occurred during a 1-month interval between irradiation and wounding; the cells responded with no delay, but the intensity of the response (i.e., the amplitude of the wave of cell labeling) was only about half that of control (unirradiated) epithelia. Irradiation at 12 hr after wounding, 2 hr before the onset of DNA synthesis, had little effect on DNA synthesis, but did delay and decrease the amplitude of the mitotic response. Irradiation at 22.5 hr after wounding, 1.5 hr before the onset of mitosis, delayed mitosis at least 7 to 8 hr. In unirradiated epithelia, the first of the responding intermitotic (G_0) cells made the transition from G_0 to G_1 and completed G_1 activities (including preparations for DNA synthesis) in about 12 or 13 hr, began DNA synthesis (the S period) 13 to 14 hr after wounding, and began mitosis (the M period) about 24 hr after wounding, about 10 hr after they had begun DNA synthesis. Some of these cells, at least, may have completed the S period in 4 to 5 hr and G_2 activities (including other preparations for mitosis) in about 6 more hr. It is postulated that the responding cells entered into and progressed through the cell cycle as successive groups or pulses of cells centered about 4 hr apart. (auth)

15741 EVALUATION OF RADIATION INJURY FROM A NUCLEIC ACID DETERMINATION IN THE BLOOD. Kritskii, G. A.; Aleksandrov, S. V. (Inst. of Biochemistry, Moscow). Dokl. Akad. Nauk SSSR; 209: No. 3, 728-731(1973). (In Russian).

White Wistar rats were subjected to x radiation in doses of 2, 5, 50, and 500 R, and changes in the nucleic acid content of the blood were determined from 1 to 7 hr after irradiation. Minima were observed in each of the four nucleic acid–time curves at about 2 hr, but the subsequent increasing nucleic acid values failed to achieve the initial concentration. (KSW)

15742 COMPARISON OF THE EFFECTS OF RADIATION ON TUMOUR GROWTH DELAY AND CELL SURVIVAL. The Effect of Oxygen. McNally, N. J. (Medical Research Council, London). Brit. J. Radiol.; 46: No. 546, 450-455(Jun 1973).

A tumor is described for which it is possible to measure the survival of the tumor cells in vitro following irradiation in vivo. Using this tumor (developed from the rat fibrosarcoma RIB_5), the relationship between cell survival and alterations in tumor growth after irradiation, and the effect of oxygen on this relationship were studied. The oxygen enhancement ratio for cell killing was 2.5, and for tumor growth delay was 3.0. This difference in the OER's could not be accounted for in terms of differences in post-irradiation proliferation by cells that were either oxic or hypoxic at the time of irradiation. Evidence is presented that indicates that measurements of cell survival in vitro following irradiations in vivo may lead to inaccurate estimates of the effective hypoxic fraction in a tumor. It is pointed out that the results suggest that there may be qualitative differences between the types of damage expressed in situ and in vitro, and that techniques that involve the removal of cells from their normal environment may lead to incorrect estimates of cellular radiosensitivity. (auth)

15743 RELATIONSHIP BETWEEN ZONES IN IRON CONCENTRATION AND MACROSCOPIC SURFACE COLONIES IN THE SPLEEN OF THE MOUSE RADIATION CHIMERA. Thomas, D. B. (Univ. of Birmingham, Eng.). J. Anat.; 114: No. 1, 95-100(Jan 1973).

Specific-pathogen-free female albino mice weighing between 20 and 25 g were exposed to a lethal dose (820 rads) of whole-body x irradiation. Within 2 hrs of irradiation 8.0×10^4 syngenic bone marrow cells were intraveneously injected into thirty of the irradiated mice. After 9 days, each animal received an intraveneous injection of 1 μCi ^{59}Fe and 24 hrs later the spleen was removed. Macroscopic surface colonies were counted and mapped. Autoradiographs were taken. It was found that 85% of the zones of iron concentration that are revealed in the spleen of the mouse radiation chimera by macro-autoradiography correspond in position to macroscopic surface colonies. Surface colonies that can be shown to accumulate iron outnumber those that do not appear to accumulate iron by more than four to one. The number of zones of iron concentration (FeZ) is related to the number of macroscopic surface colonies (SC) in the equation: FeZ = SC – (Co + Cf + Nc) + Dc, in which Co = the number of surface colonies obscured due to coincidence, Cf = the number of surface colonies obscured by confluence, Nc = the number of surface colonies that do not concentrate iron and Dc = the number of zones of iron concentration that do not correspond in position to surface colonies. (UK)

15744 PROLACTIN-INDUCED LUTEOLYSIS IN RATS FOLLOWING OVARIAN X IRRADIATION. Hixon, J. E.; Raud, H. R.; Armstrong, D. T. (Univ. of West Ontario, London). Endocrinology; 92: No. 6, 1667(Jun 1973).

The relationship between the follicular elements of the ovary and prolactin-induced luteolysis was investigated in PMS-synchronized, immature rats whose ovaries were subjected to 2500 rads of x irradiation. Luteolysis was not observed in sham-irradiated rats or in x-irradiated rats receiving prolactin continuously (100 μg twice daily) from the day of ovulation until autopsy 12 days later. However, when prolactin administration was stopped for a 96-hr period between day 3 and day 6 and resumed on day 7, significantly ($p < 0.01$) smaller corpora lutea were observed after 5 successive days of prolactin administration when compared to irradiated rats receiving continuous prolactin. The interrupted prolactin regime, which successfully induced luteolysis when bilateral irradiation was carried out, failed to induce luteolysis in unilaterally x-irradiated rats. Prolactin-induced luteolysis in bilaterally x-irradiated rats was prevented by the administration of 1.0 μg of estradiol-17β per day between the time of irradiation and the initiation of prolactin treatment. However, this protective effect of estradiol appeared not to be a direct effect on the corpora lutea since estradiol failed to protect corpora lutea against the luteolytic action of prolactin in hypophysectomized rats. Determinations of serum prolactin levels in sham- and x-irradiated rats revealed that estradiol elevated prolactin levels in both cases. The possibility that high prolactin levels may actually prevent prolactin-induced luteolysis is discussed. The failure to detect any differences between serum prolactin levels in sham- and x-irradiated rats would seem, however, to rule our circulating prolactin levels as the determining influence that allows the expression of prolactin-induced luteolysis. (auth)

15745 COMPARATIVE EFFECTS OF DOSE PROTRACTION AND RESIDUAL INJURY IN DOGS AND MONKEYS. Spalding, J. F.; Holland, L. M.; Prine, J. R.; LaBauve, P. M.; London, J. E. (Los Alamos Scientific Lab., NM). Radiat. Res.; 54: No. 3, 453-462(Jun 1973).

Comparative effects of two dose rates and residual injury from a sublethal γ exposure were studied in dogs and monkeys. Hematopoietic response to a ^{60}Co γ exposure delivered at 66 rads/day was more pronounced in dogs than in monkeys. With a dose rate of 24 rads/day, hematopoietic response in dogs and monkeys was quite similar. Residual injury from γ exposure, as measured by reduced mean survival time in a continuous 24 rad/day γ environment, was significantly greater in dogs than in monkeys. (auth)

15746 STUDY OF THE IMMUNE MECHANISM IN MICRO-ASCARIASIS CAUSED BY ASCARIS SUUM. Effects of Whole-Body Irradiation on the Enteric Wall Reactivity Against Challenge with Infective Larvae in Vaccinated Guinea-Pigs. Casarosa, L.; Lugetti, G.; Marconcini, A. (Univ., Pisa, Italy). pp 113-126 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Fifty guinea-pigs, divided into five groups, were used in the experiment. The first group (VXCh Group) was doubly vaccinated against Ascaris suum by oral administration of A. suum embryonated eggs and 15 days after the second vaccinal dose, irradiated with a total dose, according to the animal's weight, of 450-470 R. Two days after irradiation the animals were challenged with an oral dose of 3000 A. suum embryonated eggs. The second group (VCh Group) was vaccinated as above and challenged with an oral dose of 3000 A. suum embryonated eggs. The third group (Ch Group) received only an oral challenge infection of 3000 A. suum embryonated eggs. The fourth (V Group) and fifth (VX Group) groups were vaccinated, or vaccinated and irradiated, as above, but not subjected to challenge infection. The guinea-pigs of the first, second and third group were killed at the 24th and 48th hour after challenge infection; the intestine and the liver were examined for challenge A. suum larvae. There was an increase in the intestinal permeability and an increase in hepatic receptivity to the second stage larvae in Group VXCh, compared with Groups VCh and Ch. All the larvae found in the liver were of normal appearance and viable. On the contrary, a great number of the larvae found at the enteric level both in vaccinated and challenged and in vaccinated, irradiated and challenged animals had granular or amorphous material or cells attached to the cuticle; these larvae were considered as locally retained. No larvae were found at the intestinal and hepatic level in the fourth and fifth animal groups which were killed on the 33rd and 34th day after the beginning of the experiment. The adherence reactivity between retained larvae and cells was investigated by using the second stage A. suum larvae (artificially hatched) and peritoneal macrophages or peritoneal eosinophils, collected both from the vaccinated and vaccinated and irradiated animals. A lower percentage of adherence reaction was seen when peritoneal cells from the irradiated animals were used. (auth)

15747 STUDIES ON THEILERIA PARVA IN WHOLE-BODY IRRADIATED MICE. Irvin, A. D.; Brown, C. G. D.; Cunningham, M. P.; Crawford, J. G.; Ledger, M. A. (East African Veterinary Research Organization, Nairobi, Kenya). pp 155-159 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Three groups each of 20 mice were irradiated at 900 R. Groups 1 and 2 were inoculated subcutaneously with 6×10^7 and 6×10^5 cells respectively from a tissue culture suspension of Theileria parva (Muguga) infected bovine lymphoid cells. Group 3 were uninoculated controls. Tumours containing macroschizont-infected lymphoid cells developed at the site of inoculation in Group 1 mice but not in mice of Group 2. Lymphoid cells were progressively destroyed within the tumours with a consequent increase in extracellular macroschizonts. Microschizonts were occasionally seen, but no piroplasms. There was no evidence that parasites had invaded mouse cells, nor that mouse cells were involved in tumour formation. Parasitized cells from tumours were successfully transferred back to tissue culture and also into other irradiated mice. (auth)

15748 IMMUNOLOGICAL MEMORY IN RADIATION CHIMERAS. Gengozian, N.; Congdon, C. (Oak Ridge Associated Universities, TN). Transplantation; 16: No. 1, 32-40(Jul 1973).

Humoral antibody formation in the long-term allogeneic radiation chimera was found to be dependent on the type and dose of antigen and the degree of secondary disease experienced. The antigen most capable of revealing a defect in the immunological mechanism of these murine chimeras was rat red blood cells (RBC), a phylogenetically closely related antigen. Thus, two different allogeneic chimera combinations, with contrasting incidence and severity of secondary disease, failed to mount significant antibody titers to rat RBC even after repeated immunizations. Sheep RBC and Salmonella typhosa antigens, although evoking a subnormal response after primary immunization, were capable of inducing normal antibody titers after two or more injections. The consistent immunological defect, independent of antigen type, dose, and incidence of secondary disease, was the inability of these animals to show normal conversion from 19 S to 7 S antibody synthesis. On this basis it is speculated that the deficiency in the allogeneic chimera lies in the T cell component of the immune system, since 7 S antibody formation has been shown by others to be a thymus-dependent function. (auth)

15749 LOCALIZED X-IRRADIATION OF MURINE INTESTINE: CHANGES IN GOBLET CELL FORMATION, CELL PROLIFERATION, AND CELL MIGRATION. Cooper, J. W. Iowa City, IA; Univ. of Iowa (1972). 106p. University Microfilms Order No. 73-13,516.

Thesis (Ph. D.).

Male Holtzman rats received x-ray exposures of 500, 1000, or 1800 R to only the exteriorized ileum and jejunum. Quantitative assessments were made of goblet cell formation, cell proliferation and cell migration in the irradiated and adjacent unirradiated segments. The influence of the gut exteriorization procedure on DNA synthesis in duodenum and colon was also studied. X-irradiation resulted in a transient increase in the number of mature goblet cells in the irradiated segment. The peak values for goblet cells were 133 percent of control at 1 day after 500 R and 145 percent of control at 1 day after 1000 R. The peaks were followed by a nadir of 71 percent of control at 3 days after 500 R and 44 percent of control at 3 days after 1000 R. A marked increase in goblet cell size was also evident during this period. The average goblet cell diameter increased from 7 μ for controls to 9.6 μ at one day after 500 R, 10 μ at 2 days after 1000 R and 9.5 μ at one day after 1800 R. The average crypt cell diameter increased from 5.9 μ for controls to 6.6 μ at 2 days after 500 R, 7.7 μ at 2 days after 1000 R and 8.3 μ at 2 days after 1800 R. There was also a compensatory response in epithelial cell kinetics in adjacent unirradiated segments proximal (duodenum) and distal (colon) to the irradiated segment. The response consisted of a transient increase in epithelial cell proliferation and migration. The maximum tritiated thymidine uptake in duodenum was 163 percent of control at 1 day after 500 R, 146 percent of control at 1 day after 1000 R and 166 percent of control at 7 days after 1800 R. In the colon, maximum values were 162 percent of control at 1 day after 500 R, 171 percent at one day after 1000 R and 184 percent at one day after 1800 R. Exteriorizing the entire ileum and jejunum of rats for 15 minutes had no effect on tritiated thymidine uptake in duodenum or colon. Male C57 B1/J mice were labeled with tritiated thymidine prior to receiving an exposure of 1000 R of x-irradiation to the abdomen only. Following irradiation, crypt cell migration was blocked for a period of 6 to 8 hours. (Diss. Abstr. Int., B)

15750 LONG-TERM EFFECTS OF IONIZING RADIATION ON THE RAT SPINAL CORD: INTRAMEDULLARY CONNECTIVE TISSUE FORMATION. Gilmore, S. A. (Univ. of Arkansas, Little Rock). Amer. J. Anat.; 137: No. 1, 1-18(May 1973).

The effects of ionizing radiation on spinal cords of rats irradiated when three days of age and killed at intervals up to 28 months after irradiation were evaluated by light microscopy. The amounts of x rays administered (2,000 R; 1,000 R; 500 R) were those demonstrated by short-term studies in this laboratory to cause either no histopathologic changes or only transient, reparable alterations. The most significant and previously unreported finding was the development, usually restricted to the gray matter, of elongated, spindle-shaped cells that produce prodigious amounts of fibers clearly demonstrated by the Wilder's reticular stain. In cases where extensive cellular development had occurred, these cells were oriented around the perikarya of the large ventral motor neurons and formed a well-developed capsule of reticular fibers. This phenomenon occurred more frequently in rats receiving the greater amounts of radiation and killed 12 months or more after exposure. The other observation of interest was the development of lesser amounts of connective tissue-producing cells in the dorsal gray matter, where these cells were seen initially in the substantia gelatinosa. The significance of these changes is discussed in relation to previously reported long-term effects of ionizing radiation on the central nervous system. (auth)

15751 INTERFERON INDUCTION IN NEW ZEALAND BLACK MICE BY MURINE LEUKEMIA VIRUS. Siegel, B. V.; Brown, M.; Morton, J. I. (Univ. of Oregon, Portland). J. Immunol.; 3: No. 2, 644-646(Aug 1973).

Mice were inoculated intraperitoneally with spleen extract infected with Rauscher leukemia virus. At intervals the animals were bled for interferon assay. The interferon response was compared in virus-inoculated and uninoculated control mice. Both interferon production and viral leukemogenesis increased progressively with age. Two age groups, 6 and 13 months old, were exposed to whole-body x radiation. Four days later, irradiated and control mice were inoculated with a virus suspension and bled 30 hr later for interferon assay. The data demonstrated that virus-induced interferon production was highly radiosensitive, suggesting that cells derived from the hemopoietic system were involved in the production. (HLW)

15752 EFFECT OF IRRADIATION AND APPENDICOSTOMY ON APPENDIX STRUCTURE AND RESPONSES OF APPENDIX CELLS TO MITOGENS. Blythman, H. E.; Waksman, B. H. (Yale Univ., New Haven). J. Immunol.; 111: No. 1, 171-182(Jul 1973).

A quantitative morphologic analysis was made of changes in the appendix nodule in rabbits receiving sublethal whole body irradiation and in others after ligation of the base of the appendix, appendicostomy, and sterilization of the appendix lumen. After 450 R, the dome, the thymus-dependent area (TDA), and the follicle (thymus-independent area) all decreased rapidly in size to a minimal value at 7 days, and then began to regenerate. The follicle shrank more rapidly and to a greater extent than the TDA. After appendicostomy, the dome maintained its volume for 10 days, then slowly decreased in size. The TDA and follicle began to shrink immediately and in parallel, diminishing by 10 to 14 days to a size comparable to that in irradiated rabbits. If irradiation were superimposed on appendicostomy, these tissue elements diminished still further. The dome showed partial regeneration. When cultured 7 days after irradiation, cells of the appendix, sacculus rotundus, and draining mesenteric lymph node (but not the Peyer's patches or spleen) showed an elevation in response to Phytohemagglutinin (PHA), presumably reflecting a relative decrease in B cells and increase in radioresistant T cells. This had largely disappeared by 14 days. After appendicostomy and lumen sterilization, the PHA response of appendix cells began to increase at 7 days together with that of cells from the mesenteric node, and became quite elevated at 14 days, while cells of the sacculus, Peyer's patches and spleen showed no change. After appendicostomy and irradiation, the response of appendix cells to PHA remained relatively elevated. Concanavalin A (ConA) responses in general paralleled response to PHA. Cells of the gut-associated lymphoid organs showed a much lower ratio of responses to ConA and PHA than did lymph node cells, and this ratio was less than 1.0 in the acute phase (3 and 7 days) of irradiation injury. Endotoxin produced little stimulation at any time. (auth)

15753 UNSCHEDULED SYNTHESIS OF DNA DURING MAMMALIAN SPERMATOGENESIS IN RESPONSE TO UV IRRADIATION. Gledhill, B. L.; Darzynkiewicz, Z. (Univ. of Pennsylvania, Kennett Square). J. Exp. Zool.; 183: No. 3, 375-382(Mar 1973).

Unscheduled incorporation of tritium-labeled thymidine into nuclear DNA, induced by uv irradiation and presumed to indicate DNA repair replication, was followed in differentiating male germ cells of the rat and rabbit by quantitative autoradiographic techniques. Cells at various stages of differentiation incorporated [^{3}H] thymidine at different rates. The maximal rate was observed in nuclei of pachytene primary spermatocytes; the rate was markedly lower in spermatogonia and in leptotene and zygotene primary spermatocyte nuclei. No evidence of incorporation was found for nuclei of spermatids and testis spermatozoa. (auth)

Invertebrates

15754 (STI/PUB-328) ISOTOPES AND RADIATION IN PARASITOLOGY III. Panel Proceedings Series. Proceedings of a Research Co-Ordination Meeting, Kabete, Kenya, November 22-26, 1971. (International Atomic Energy Agency, Vienna (Austria)). Feb 1973. 209p. (CONF-711153-). IAEA $8.00.

Separate abstracts were prepared for 21 papers presented at the conference. An additional three papers were presented on various aspects of parasitology. (HLW)

For abstracts of individual papers see: 15689, 15698-15702, 15746, 15747, 15759-15766, 15816, and 15831-15834.

15755 GEOGRAPHIC VARIATION IN SENSITIVITY TO X IRRADIATION IN TRIBOLIUM. I. Differences in Adult Emergence Due to Species, Strain, and Age at Population. Soliman, M. H. (Univ. of Alberta, Edmonton). Radiat. Res.; 54: No. 3, 510-520 (Jun 1973).

Populations of Tribolium castaneum and T. confusum with different geographic background were examined in regard to their sensitivity to ionizing radiation as measured by percent of adult emergence after single exposure: 10 kR of x rays at 33°C and 70% relative humidity. Second day pupae only were irradiated. T. castaneum exhibited a marked population difference in sensitivity to x-irradiation with a range from 6.80% (Canada) to 47.53% (Kenya) of adult emergence after irradiation. In this respect, T. confusum ranged from 1.69% (Chicago) to 11.74% (Kansas). In general, T. confusum was more radiosensitive than T. castaneum (the overall percent of emergence was 5.35 and 28.48, respectively). Within populations, increasing pupation time is associated with decreasing sensitivity to ionizing radiation. Physiological and genetical factors that might be the cause of intra- and interspecies differences are discussed. (auth)

15756 SENSITIVITY OF ORYZAEPHILUS SURINAMENSIS TO CESIUM-137. II. Irradiation of Larvae, Pupae, and Adults. Chawla, S. S.; Perron, J. M.; Huot, L.; Corrivault, G. W. (Laval Univ., Quebec). J. Econ. Entomol.; 65: No. 3, 605-608(Jun 1973).

Irradiation doses of 2580 rads of cesium-137 depressed the fecundity and reduced the fertility of adults of the sawtoothed grain beetle whereas doses of 10,320 rads affected their longevity. Larvae were more sensitive to the lethal effects of cesium-137 irradiation than the pupae. Doses of 2580 and 3870 rads decreased the fecundity of the adults that emerged from irradiated larvae and pupae, respectively. (auth)

15757 GEOGRAPHIC VARIATION IN SENSITIVITY TO X-IRRADIATION IN TRIBOLIUM. II. Incidence of Developmental Abnormalities. Soliman, M. H. (Univ. of Alberta, Edmonton). Radiat. Res.; 54: No. 3, 521-530(Jun 1973).

Induction of developmental abnormalities was studied after x-irradiation of two-day-old pupae of various "geographic" populations of Tribolium castaneum and T. confusum. Canadian populations were the most sensitive; 21.1% showed the split wing abnormality in T. castaneum, and 37.5% showed this in T. confusum. Kenyan populations were the most resistant. They showed 1.0% abnormalities in T. castaneum and 16.7% in T. confusum. In general, T. castaneum was more resistant than T. confusum with 5.5% and 18.6% split wing abnormalities being produced, respectively. Length of the pupal stage was studied in T. castaneum. The pupal period decreased with increasing age at which larvae pupated. Emerged adults after irradiation had shorter pupal periods than their controls. This finding is contrary to earlier records, by other investigators, on eclosion delay using lower doses of x-irradiation and different pupal ages. Choice of dose, criteria, and consideration of the consequences of the choice of age at exposure are also discussed. (auth)

15758 INTERACTION OF FORMALDEHYDE AND X-RAYS ON MUTATION PRODUCTION IN DROSOPHILA MELANOGASTER. Mahajani, S.; Chopra, V. L. (Indian Agricultural Research Inst., New Delhi). Curr. Sci. (India); 42: No. 13, 473-474(5 Jul 1973).

Following combined treatment of Drosophila larvae with x rays and formaldehyde no significant effect was found on the frequency of lethal mutations. However, there was a ten-fold increase in the frequency of yellow flies in the progeny of irradiated flies. The possible mechanisms of the enhanced mutation frequency resulting from the combined treatments are discussed. (HLW)

15759 PRELIMINARY STUDIES ON THE IMMUNIZATION OF CATTLE AGAINST FASCIOLIASIS USING GAMMA-IRRADIATED METACERCARIAE OF FASCIOLA GIGANTICA. Bitakaramire, P. K. (Univ. of Nairobi, Kenya). pp 23-32 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

A preliminary experiment in which gamma-irradiated metacercariae of Fasciola gigantica were used to immunize cattle against fascioliasis is described. Twenty-four 6-months-old male calves free from Fasciola gigantica (liver fluke) were randomly subdivided into six groups and subjected to the following treatment: two groups received, on day 0 and day 42, two oral doses of each 1000 metacercariae of Fasciola gigantica which had been gamma irradiated with 3000 rad. One of these groups was challenged, on day 140, with infective, non-irradiated metacercariae. Another three groups received 1000 infective metacercariae on day 0, 42 and 140 respectively, whereas the remaining group served as untreated controls. Autopsies were made on day 84 or 224, and the livers were checked for recovery of developed parasites and histological alterations. Ten weeks after challenge, three animals of each group were injected with ^{125}I-labelled albumin and ^{59}Fe as ferric citrate to determine the effects of the administration of metacercariae on albumin and iron turnover. In the group double-vaccinated with irradiated metacercariae 84 days after challenge, five animals did not have any worm burden and did not show liver alterations, whereas two calves had a recovery of 1-2% of the challenge dose and slight bile duct thickening. An average recovery of 23.1% of the challenge dose was observed in the non-vaccinated groups, 84 days after challenge. Gross and microscopical lesions were found in the livers of these animals. Albumin turnover and catabolic rate was significantly increased in the non-vaccinated groups as a result of the infective challenge dose. Iron metabolism was only slightly affected in the non-vaccinated groups and as a result of the infective challenge dose. This is attributed to the fact that the animals were sacrificed before anaemia had developed. (auth)

15760 IRRADIATED VACCINE FOR CONTROL OF DICTYOCAULUS FILARIA IN INDIA. Tewari, H. C.; Dhar, D. N.;

Singh, K. S. (Indian Veterinary Research Inst., Izatnagar). pp 43-50 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

An approach to the problem of lungworm infection in sheep in India is described, and its control by using a radiation-attenuated antihelminthic vaccine. Following extensive laboratory studies, a vaccine comprising infective larvae of Dictyocaulus filaria irradiated at 50 kR of gamma rays has been developed. A large-scale pilot experiment used this vaccine in sheep in the endemic areas of Kashmir, India. The results indicate that the vaccine confers a high degree of protection on sheep against D. filaria infection. The incidence and the identity of the species of lungworm prevalent in Kashmir have been established. Serological studies have shown that there was no correlation between the antibody response and the ability of hosts to withstand challenge infection. (auth)

15761 EXPERIMENTS ON THE ACQUIRED RESISTANCE OF SHEEP AND GOATS INDUCED BY INFECTIONS WITH IRRADIATED AND NON-IRRADIATED LARVAE OF DICTYOCAULUS FILARIA. Kassai, T.; Altaif, K. I.; Kadhim, J. K.; Jabbir, M. H.; Bayyar, H. A. (UNDP/FAO, Near East Animal Health Inst., Baghdad). pp 51-60 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Two experiments are described. In the first a laboratory study was carried out on small groups of one-year-old sheep and goats which were double dosed with controlled numbers of pathogenic and radiation-attenuated Dictyocaulus filaria larvae and then challenged. Some of the experimental groups, after application of larvae, were treated to remove any residual infection. According to worm recoveries 39 to 46 days after challenge, marked resistance was acquired by both sheep and goats following infections with normal larvae. Irradiated larvae failed to prevent re-infection of sheep but conferred protection on three out of five goats. In the second experiment active immunization with irradiated larvae compared with anthelminthic treatments was used in field conditions to control ovine dictyocaulosis. Assessed by the number of dictyocaulus-positive faecal samples in vaccinated, treated and control groups no protection was shown in the vaccinated sheep. The authors point out the necessity to clarify further the conditions in which radiation-attenuated D. filaria vaccine can be used effectively in field control operations and to establish criteria which will adequately measure the protective efficacy of the vaccine. (auth)

15762 USE OF NUCLEAR TECHNIQUES IN THE CONTROL OF ASCARIDIA GALLI IN INDIA. Investigations on Immunization of One-Week-Old Chicks with Irradiated Eggs. Subramanian, G.; Singh, K. S. (Indian Veterinary Research Inst., Izatnagar). pp 67-71 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Eggs of Ascaridia galli were recovered from host faeces, cultured for 12 d and exposed to 15 kR. One-week-old White Leghorn chicks were infected with 500 irradiated embryonated eggs along with a control group which received untreated eggs from the same batch. The percentage establishment of the parasites in chicks infected with 500 irradiated eggs ranged from 1.2 to 14.4% (average 6.8%) whereas in those chicks which received untreated eggs it was 3.8 to 25.2% (average 8.1%). The male:female ratio of worms developing from untreated eggs was approximately 1:2. Female worms only developed from the irradiated eggs. When challenged one month later with 1000 embryonated but untreated eggs, there was little evidence for an enhanced resistance-inducing effect. The results are discussed in relation to innate age immunity and a partial or complete expulsion of the worm burden. (auth)

15763 PATHOLOGY AND IMMUNOLOGY OF ANIMAL SCHISTOSOMIASIS IN AFRICA. Hussein, M. F.; Amin, M. B. A. (Univ. of Khartoum, Sudan). pp 91-100 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Animal schistosomiasis in Africa is an important helminthic disease, greatly undermining the health of livestock and reducing their productivity. The causative parasites, Schistosoma bovis and S. mattheei, are known to produce an intestinal form of schistosomiasis in which pathological lesions are found in the intestinal tracts, liver and associated lymph nodes. In severe cases, other organs including the pancreas, spleen, abomasum, fore-stomachs, lungs and urogenital tracts are affected, and the disease is manifested clinically by diarrhoea, emaciation, dehydration, eosinophilia and changes in the serum proteins. The immunology of schistosomiasis in domestic animals has received little attention and the need for thorough investigations on this problem is indicated. (auth)

15764 EXPERIMENTAL STUDY ON THE PROTECTION OF CHICKENS AND PHEASANTS AGAINST SYNGAMOSIS BY USE OF IRRADIATED LARVAE. I. Methods for Immunizations, Preparation of Immunizing Material and Identification of Serum Antibodies by Immunofluorescence. Feteanu, A.; Stoican, E.; Negru, D.; Verdes, N. (Pasteur Inst. for Veterinary Research and Biological Preparations, Bucharest). pp 101-111 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Syngamus trachea larvae irradiated with ^{60}Co gamma rays at a dose of 10 kR become biologically attenuated, do not achieve their complete developmental cycle, and when orally administered, induce an immune-type resistance in young chicks and pheasants. This immunity was demonstrated by the presence of specific IgG-type serum antibodies directed particularly against antigens present in the larvae, but also against antigens located in some structures of the eggs. The presence of specific serum antigens was demonstrated by the fluorescent antibody technique. Practical application of irradiated larvae for prevention of syngamosis seems possible, in which case immunity could be checked by the fluorescent antibody technique. (auth)

15765 PRELIMINARY STUDIES ON THE IMMUNIZATION OF CATTLE AGAINST EAST COAST FEVER USING IRRADIATED TICKS RHIPICEPHALUS APPENDICULATUS INFECTED WITH THEILERIA PARVA. Mugera, G. M.; Bitakaramire, P. K.; Munyua, W. K. (Univ. of Nairobi, Kenya). pp 129-137 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Thirty calves 9-12 months old were each given ten adult Rhipicephalus appendiculatus ticks infected with Theileria parva, irradiated at 0, 10, 20, 30, 50 and 70 kR of gamma radiation. Non-irradiated ticks were attached to 4 calves, ticks irradiated at 10 kR to 9 calves, ticks irradiated at 20 kR to 4 calves, ticks irradiated at 30 kR to four calves, ticks irradiated at 50 kR to 5 calves and ticks irradiated at 70 kR to 4 calves. The ticks irradiated at 70 kR failed to become attached to the calves. Infected ticks irradiated at 10 kR before application to calves and non-irradiated ticks produced fatal East Coast fever. Infected ticks irradiated at 20, 30 and 50 kR did not induce clinical East Coast fever but circulating antibodies against the disease were demonstrated by the capillary agglutination test. These calves were challenged 35 d later using for each calf infected non-irradiated adult Rhipicephalus appendiculatus ticks. The calves infected with ticks irradiated at doses of 20 and 30 kR resisted the challenge, indicating that they were successfully immunized. Three calves out of five infected with ticks irradiated at 50 kR died with typical East Coast fever on challenge. Another experiment compared the difference in the immunity produced by application of irradiated ticks at 30 kR with that produced by application of tick tissue obtained from ticks irradiated at 30 kR and injected subcutaneously. Using both methods a high degree of immunity against East Coast fever was obtained. (auth)

15766 ^{60}Co-IRRADIATION OF THE TICK RHIPICEPHALUS APPENDICULATUS. Purnell, R. E.; Dargie, J. D.; Irvin, A. D.; Ledger, M. A. (East African Veterinary Research Organization, Nairobi, Kenya). pp 139-144 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Groups of Rhipicephalus appendiculatus ticks were given a single dose of irradiation (range 0.25 to 16 kR) at different stages in their life cycle: unfed nymphs, engorged nymphs, moulting nymphs and unfed adults. The effects of irradiation were assessed by evaluating the subsequent performances of the ticks when fed on rabbits. Observations were carried through until the viability of egg batches from surviving females had been recorded. Irradiation of unfed and engorged nymphs produced similar effects on the ticks, whereas irradiation of moulting nymphs and adults produced effects that were different from those produced on the other two groups but similar to each other. Moulting nymphs and adults were generally better able to survive irradiation, and consequently attempts to investigate the effects of irradiation on Theileria parva in tick salivary glands were carried out on adult ticks. Infected

ticks were irradiated at doses of 0-32 kR and then fed on rabbits for 3 or 4 d. Their salivary glands were then removed, processed and examined for parasites. Increasing doses of irradiation resulted both in a decreased infection rate of ticks and a decrease in the number of parasite masses observed in infected ticks. No normal parasite masses were seen after doses of 4 kR or above. (auth)

15767 EFFECTS OF GAMMA RADIATION ON THE BIOLOGY AND POPULATION SUPPRESSION OF THE TWO-SPOTTED SPIDER MITE, TETRANYCHUS URTICAE KOCH. Neson, R. D.; Stafford, M. (Driscoll Strawberry Associates Inc., Watsonville, CA). Hilgardia; 41: No. 12, 299-342(Oct 1972).

Some biological effects of gamma radiation on the two-spotted mite, Tetranychus urticae Koch were determined. A substerilizing dose given to a male subsequently mated to a normal female caused sterility in the F_1 female progeny. LD50/10 values for adult males and females were established at 90 and 110 krads, respectively. Eggs were more radioresistant as they aged; 3,000 to 3,200 rads were lethal to all one- and two-day-old eggs, while most all three- and four-day-old eggs hatched after an exposure to 11,500 rads. Male protonymphs, deutonymphs, and adults were all rendered sterile, and eggs and larvae were killed with 20 krads. A dose of 100 krads did not appear to cause sperm inactivation in males. The tests supported the belief that males undergo multiple matings. The eggs of about 10 per cent of the females undergoing secondary matings were successfully fertilized by more than one male. A sterilizing dose for males did not detrimentally alter mating competitiveness or longevity. Control of this species in strawberries was attempted using the sterile-male technique. Field release of both sexes caused plant damage due to additional feeding activity. An all-male colony was obtained from isolated virgin females, but not enough males could be reared, sterilized, and released to reduce the endemic field population. (auth)

15768 DOMINANT LETHALS IN THE IMMATURE STAGES OF CULEX PIPIENS MOLESTUS INDUCED BY GAMMA IRRADIATION OF THE PARENTAL PUPAE. Abdel-Malek, A. A.; Ahmed, S. H. (Univ. of Cairo). Vestn. Cesk. Spolecnosti Zool.; 36: No. 4, 233-236(Nov 1972).

The percentage of induced dominant lethals in the moisture stages of Culex pipiens molestus resulting from gamma-irradiated parental pupae significantly increased with the increase in the dose from 500 to 7750 R reaching 95.4% at 7750 R. The induced larval lethality also significantly increased when increasing the dose from 2000 to 5500 R. At 6000 R, the larval mortality reached 100%. No significant effects appeared in the F_1 pupal stage. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 15712 and 15793.

15769 (BNWL-1750(Pt.1), p 53) EVALUATION OF POSTMORTEM HUMAN TISSUE SAMPLES: U. S. TRANSURANIUM REGISTRY. Nelson, I. C.; Thomas, V. W. Jr. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The collection of postmortem tissue samples (lung, liver, bone, and tracheobronchial lymph nodes) from individuals residing or formerly residing in the vicinity of the Hanford complex continued during 1972. Samples collected since 1949 have been analyzed for content of transuranium elements. (CH)

15770 (BNWL-SA-4724) EVALUATIONS OF INTAKE AND DEPOSITION BASED ON BIOASSAY DATA. Held, K. R. (Battelle Pacific Northwest Labs., Richland, Wash.). 1973. 36p. (CONF-730603-8). Dep. NTIS $4.00.

From 18th Health Physics Society meeting; Miami Beach, Florida, USA (17 Jun 1973).

The current trend of the ICRP appears to be to de-emphasize body or organ burden evaluations and to stress the desirability of describing an intake in terms of dose commitment. This will usually require several measurements and/or evaluations over a period of time sufficient to enable one to take a detailed look at the organ retention. Systemic burdens of plutonium are still best estimated from urinary excretion data. Several methods for making evaluations for Pu, Am, Cm, U, and tritium are presented. These range from a prompt guesstimate based on data available within a few hours after the intake occurs to interim and finally more sophisticated evaluation techniques. (auth)

15771 VOCAL CORD PARESIS FOLLOWING RADIOACTIVE IODINE THERAPY. Craswell, P. W. T. (Univ. of Queensland, St. Lucia, Australia). Brit. J. Clin. Pract.; 26: No. 12, 571-572(Dec 1972).

As there are at present three modes of treatment for hyperthyroidism, it is necessary to consider not only the efficacy of each treatment but also the incidence of adverse effects. Despite a high incidence of hypothyroidism, other side-effects of radioiodine are so mild as to make it the treatment of choice for an adult with hyperthyroidism. Injury to the recurrent laryngeal nerve causing vocal cord paralysis is a major hazard of thyroid surgery, but has not been reported to occur after radioiodine therapy. For this reason the present case is described in some detail. (auth)

15772 THYROID CANCER AFTER RADIOACTIVE IODINE DIAGNOSTIC PROCEDURES IN CHILDHOOD. Pilch, B. Z.; Kahn, C. R.; Ketcham, A. S.; Henson, D. (National Inst. of Health, Bethesda, MD). Pediatrics; 51: No. 5, 898-902(May 1973).

A case of mixed papillary and follicular thyroid carcinoma, metastatic to cervical lymph nodes, in a 20-year-old woman who had undergone diagnostic radioactive iodine procedures at 4 and 12 years of age, is described. In this patient, calculation of radiation dose to the thyroid suggests that these procedures may have significantly increased the risk of development of thyroid malignancy. (auth)

Animals

15773 (BNWL-1750(Pt.1), pp 1-3) STRONTIUM-90 STUDIES IN MINIATURE SWINE: MORTALITY AND TUMOR INCIDENCE. Ragan, H. A.; McClanahan, B. J.; Hackett, P. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Studies to assess the long-term effects of daily ^{90}Sr feeding in miniature swine continue. An analysis of mortality using a life-table method showed that feeding 1 to 5 μCi/day did not affect survival nor did 25 μCi/day if given only during adult life. A number of measures, including neutrophil levels, uterine tumor incidence, myeloproliferation and leucocyte phagocytosis, were found to be altered substantially, particularly at the higher levels of feeding. (auth)

15774 (BNWL-1750(Pt.1), pp 3-7) STRONTIUM-90 STUDIES IN MINIATURE SWINE: HEMATOLOGY AND CLINICAL CHEMISTRY. Hackett, P. L.; Ragan, H. A. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Blood from miniature swine ingesting ^{90}Sr was analyzed for a number of components in an attempt to characterize the clinical state. Several measures, including levels of thrombocytes, neutrophils, and glutamic oxaloacetic transaminase, as well as the phagocytic capacity of leukocytes, were altered as a result of the ^{90}Sr regimen. (auth)

15775 (BNWL-1750(Pt.1), pp 7-8) AGE-RELATED EFFECTS OF ^{131}I IN RATS. Sikov, M. R.; Mahlum, D. D. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Recently completed studies on the long-term effects of ^{131}I have shown age-related differences in the susceptibility to induction of thyroid and pituitary tumors. Manipulation of pregnant rats appears to increase the incidence of thyroid tumors and induced a variety of adrenal alterations in offspring. (auth)

15776 (BNWL-1750(Pt.1), pp 9-10) AGE-RELATED EFFECTS OF ^{239}Pu IN RATS. Mahlum, D. D.; Sikov, M. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

An experiment, still in progress, compares the long-term effects of monomeric ^{239}Pu administered to rats at various ages. Bone tumor incidence is initially higher in males than in females and in animals injected as adults. (auth)

15777 (BNWL-1750(Pt.1), p 11) PLUTONIUM-239 IN MINIATURE SWINE. Mahlum, D. D. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The last of the miniature swine injected intradermally with 0.0016 to 5 μCi of ^{239}Pu approximately 11 yr ago was necropsied, and tissues taken for histologic examination and radiochemical analyses. There were minimal skin lesions and none of these animals showed gross evidence of skeletal tumors. The radiochemical data from these animals was used to calculate radiation doses, particularly to the liver and to the skeleton. A number of liver lesions, including tumors, were noted and attempts are being made to determine whether these are in excess of those normally expected. (CH)

15778 (BNWL-1750(Pt.1), pp 12-13) EINSTEINIUM-253 AND BERKELIUM TOXICITY AND METABOLISM IN RATS. Mahlum, D. D.; Hungate, F. P.; Sikov, M. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Rats injected with ^{253}Es as adults show greater mortality and osteosarcoma incidence than rats injected as weanlings. The incidence of mammary tumors was increased in males injected as adults. (auth)

15779 (BNWL-1750(Pt.1), pp 13-15) EINSTEINIUM-253 TOXICITY AND METABOLISM IN MINIATURE SWINE. Ragan, H. A.; McClanahan, B. J.; Hackett, P. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Most of a 3 μCi/kg dose of ^{253}Es citrate injected intravenously was retained in bone and liver of miniature swine and about 6% was excreted in 7 days. Granulocytes and platelets were initially depressed but returned to control levels within 4 months postinjection. Total lactic dehydrogenase (LDH) values showed an immediate decrease but had recovered within 42 days, although LDH isoenzyme patterns differed from those of controls at 235 days. (auth)

15780 (BNWL-1750(Pt.1), pp 15-16) SKIN IRRADIATION STUDIES. Mahlum, D. D. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Observations continue on the skin of Hanford miniature swine exposed 4 yr ago to graded radiation doses from ^{204}Tl plaques. No changes have occurred during the past year. Areas of 0.5 cm^2 and greater, exposed to doses of 6.25 krad and higher, appear as thin, whitened areas. Animals exposed at 8 days of age show extensive enlargement of the exposed area, accompanied by considerable scar tissue formation. A number of adult rats were exposed a year ago to as much as 50,000 rads from plaques of ^{239}Pu. Since newborn rats were sensitive to carcinogenic effects of ^{204}Tl radiation, the ^{239}Pu study was extended to include exposure of newborn rats with doses up to 50,000 rads. At the present time, gross damage has been minimal in animals of either age and is limited to a slight outline of the exposed areas in a few animals. (auth)

15781 (BNWL-1750(Pt.1), p 16) ELECTRON MICROSCOPIC STUDIES OF X-RADIATION EFFECTS ON LIPID ABSORPTION. Hampton, J. C. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Radiation damage to the gastrointestinal tract was assessed using electron microscopic autoradiography to follow the absorption of lipid in the jejunum and ileum. A mixture of 0.2 ml safflower oil containing 1.3 mCi ^{3}H-palmitic acid was administered to mice by stomach tube at various times after whole-body x irradiation with 1500 R. Electron microscopic examination of sections revealed a close correlation between the amount of lipid absorbed, the number of chylomicrons present, and the amount of ribosomes present in epithelial cells. The ileum was most affected and showed moderate to substantial reduction in ribosomes at 3 days postexposure to 1500 R; this finding correlated well with a sharp reduction in chylomicron synthesis. At 3.5 to 4 days postexposure, denuded villi began to develop, accompanied by nearly complete cessation of absorption and almost total depletion of ribosomes. Lacteals remained open on villi that retained their epithelial covering, but blood capillaries were usually occluded. Beginning between days 2 and 3, glycogen depletion in liver became apparent, and by day 4 was virtually complete. Liver cells were atrophied and vacuolated at the time when the mice were moribund. The results indicate that ribosomal content of intestinal epithelial cells is an accurate index of functional capability. (auth)

15782 (BNWL-1750(Pt.1), pp 17-18) ELECTRON MICROSCOPIC STUDIES OF X-RADIATION EFFECTS ON CAPILLARY PERMEABILITY. Hampton, J. C. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Histochemical localization of intravenously injected horseradish peroxidase was used to assess changes in vascular permeability induced by x radiation in mice. This approach has been shown to be a sensitive indicator of cell viability not only for vascular components but also for parenchymal cells in vivo. (auth)

15783 (BNWL-1750(Pt.1), pp 19-20) STUDIES WITH A PROTECTIVE AGENT IN MICE. Compound WR 2721, S-2 (3-aminopropylamino) Ethyl Phosphothioic Acid Hydrate. Hampton, J. C. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Preliminary results of tests with Compound WR 2721 (S-2(3 aminopropylamino) ethyl phosphothioic acid hydrate) in mice indicate good protection at 1500 R but no protection at 2500 R whole-body x irradiation. (auth)

15784 (BNWL-1750(Pt.1), pp 28-31) CARCINOGENICITY OF INHALED ^{238}Pu FROM CRUSHED MICROSPHERES IN RATS. Sanders, C. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Following inhalation of soluble ^{238}Pu by rats, 12 to 25% of the initial alveolar lung burden remained in the body 1 to 2 yr after exposure; 0.3 to 1% of this was in the lungs and 50% in the skeleton. The lung tumor incidence was 6.6, 23.3, and 25% for initial lung deposition of 5, 18, and 230 nCi, and average radiation doses of 9, 32, and 375 rads, respectively. There was a 1.1% incidence of lung tumors in controls. The incidence of all tumors other than mammary tumors was 4.3% in the unexposed controls and in the ^{238}Pu-exposed rats, 26.7, 36.6, and 46.8%. (auth)

15785 (BNWL-1750(Pt.1), pp 32-33) LONG-TERM BIOLOGICAL EFFECTS OF INTRATRACHEALLY INSTILLED $^{253}EsCl_3$ IN RATS. Ballou, J. E.; Morrow, W. G. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Male rats were administered 0.5 ml of $^{253}EsCl_3$ in HCl, solution (pH 2) at doses ranging from 0.214 to 47.2 μCi/kg. Retention curves were determined from rats administered 2.2 μCi $^{253}EsCl_3$. The intratracheal mode of administration was employed because only a small amount of ^{253}Es was available and an accurate measure of the administered dose was required. The long-term animals were weighed each month and observed daily for survival and gross or histopathologic lesions. The radiation dose to lung, kidney, liver, and skeleton was calculated using parameters determined from the short-term retention curves. The long-term effects of intratracheal $^{253}EsCl_3$ were characterized by a depressed rate of growth which was dose related; early death due to radiation pneumonitis in the 47.2 μCi/kg group; death due to neoplastic lesions in bone and soft tissues, and leukemia in the 10.7 μCi/kg group; and essentially no effect at the lowest level of 0.214 μCi/kg. (CH)

15786 (BNWL-1750(Pt.1), p 34) COCARCINOGENIC EFFECT OF $^{239}PuO_2$ AND ASBESTOS IN THE LUNG OF RATS. Sanders, C. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Previous studies in rats demonstrated the additive action of $^{239}PuO_2$ particles and chrysotile asbestos, deposited in the abdominal cavity, on the induction of abdominal sarcomas and mesotheliomas. The combination of both carcinogens produced as many or more of these tumors than was obtained by adding tumor incidences from the agents given singly. An experiment was initiated to investigate possibly similar effects in the lung. Four groups of rats were given intratracheal instillations of either $^{239}PuO_2$, chrysotile asbestos, $^{239}PuO_2$ + chrysotile asbestos, or saline. Particulates were suspended in 0.3 ml saline prior to instillation. The co-administration of $^{239}PuO_2$ with asbestos resulted in less excretion of ^{239}Pu than was the case with $^{239}PuO_2$ only. Focal granulomatous lesions were common around bronchiolar areas of the lung in animals receiving asbestos. Plutonium oxide particles tended to concentrate in these asbestos-induced lesions forming hot spots of alpha activity. Data on further pathologic effects are not yet available. (auth)

15787 (BNWL-1750(Pt.1), pp 37-38) DETECTION OF CYTOTOXIC LYMPHOCYTES IN BEAGLES WITH ^{238}Pu-INDUCED BONE TUMORS. Frazier, M. E. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Bone tumor cells from a beagle that had been exposed to ^{238}Pu by inhalation were injected intraperitoneally into neonatal puppies to investigate the transmissibility of ^{238}Pu-induced canine bone tumors. These animals at 9 months of age showed no evidence of tumors, but they were producing lymphocytes that were cytotoxic to cultured ^{238}Pu-induced canine bone tumor cells. Preliminary experiments suggest that cell lines prepared from ^{238}Pu-induced canine bone tumors have at least one antigen which is common to bone tumors found in other dogs that inhaled ^{238}Pu, and that dogs with these bone tumors also possess lymphocytes that are cytotoxic to cultured bone tumor cells from heterologous animals. Cultured cells from a spontaneous mammary tumor and ^{239}Pu-induced canine lung tumor cells were not killed by these lymphocytes, implying a degree of specificity based on tumor type. (CH)

15788 (BNWL-1750(Pt.1), pp 83-84) STUDIES ON THE ROLE OF VIRUS IN RADIONUCLIDE-INDUCED MALIGNANCIES: MYELOGENOUS LEUKEMIA IN MINIATURE SWINE FED ^{90}Sr. Frazier, M. E.; Ushijima, R. N.; Andrews, T. K.; Pratt, J. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

An analysis was made of one type of radiation-induced malignancy, myelogenous leukemia, in terms of a virus particle as a primary agent in its development. A survey of 46 miniature swine fed ^{90}Sr over an extended interval revealed that of 34 animals with either myeloproliferative or lymphoproliferative disorders, 21 showed virus-like particles in their tissues or in plasma pellet preparations. The finding that 15 of 19 animals with myelogenous or lymphocytic leukemia had virus-like particles present may be

of even greater significance. In contrast, no virus-like particles were observed in preparations from control animals. (CH)

15789 MORPHOLOGY AND ENZYME HISTOCHEMISTRY OF ^{224}Ra-INDUCED OSTEOSARCOMAS OF THE MOUSE. Goessner, W.; Hindringer, B.; Luz, A.; Schwabe, M. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Munich). Z. Krebsforsch.; 78: 225-235(1972). (In German).

Osteoblastic sarcomas of the mouse induced by incorporation of ^{224}Ra show various types of differentiation dependent on their location in the skeleton. Generally, tumors of the head region do not show any special osteoblastic cells whereas in tumors of other skeletal sites osteoblasts, osteoclasts, and even blood-forming tissue may be frequently observed. The histochemical demonstration of alkaline and acid phosphatase reveals different patterns of enzyme activity. (auth)

15790 DIFFERENTIAL EFFECT OF HEAVY WATER ON TEMPERATURE-DEPENDENT AND TEMPERATURE-COMPENSATED ASPECTS OF THE CIRCADIAN SYSTEM OF DROSOPHILA PSEUDOOBSCURA. Pittendrigh, C. S.; Caldarola, P. C.; Cosbey, E. S. (Stanford Univ., CA). Proc. Nat. Acad. Sci. U.S.A.; 70: No. 7, 2037-2041(Jul 1973).

The great diversity of D_2O effects on biological systems in general is briefly reviewed and the need for rejectable hypotheses concerning the action of D_2O on circadian clocks is stressed because current speculation on its action yields predictions expected from almost any hypothesis. The hypothesis that it diminishes the apparent temperature of the cell is considered and the effect of D_2O on temperature-dependent and temperature-compensated aspects of the circadian system in Drosophila is examined. These components respond as differentially to D_2O as they do to temperature; however, this result may be equivocal if the frequency of circadian oscillations is generally homeostatically conserved, not only in the face of temperature change, but change in any variable to which it is sensitive. More crucial tests of the temperature-equivalence hypothesis for D_2O action are defined. (HLW)

Plants

Refer also to abstract 15494.

Nuclide Kinetics and Toxicology

Man

Refer also to abstracts 15503, 15505, 15770, and 15772.

15791 METABOLISM OF ^{83}Rb AND ^{137}Cs IN PERSONS WITH MUSCLE DISEASE. Lloyd, R. D.; Mays, C. W.; McFarland, S. S.; Zundel, W. S.; Tyler, F. H. (Univ. of Utah, Salt Lake City). Radiat. Res.; 54: No. 3, 463-478(Jun 1973).

A double tracer of the muscle-seeking radionuclides ^{83}Rb + ^{137}Cs was administered orally to persons of various ages, 16 with and 22 without muscle disease. Retention of ^{83}Rb and especially ^{137}Cs by subjects with advanced muscle disease was generally much lower than by control subjects of corresponding age and sex. The degree of difference appeared to depend upon the severity of the disease. Biological retention was greater for ^{137}Cs than for ^{83}Rb in subjects without muscle disease, but there was a reversal of this pattern in four boys severely affected and two boys moderately affected with Duchenne dystrophy and in a 19-year-old girl severely affected with infantile muscular atrophy. Two 5-year-old boys slightly affected with Duchenne dystrophy exhibited retention patterns similar to those of two 4-year-old boys without muscle disease. There appeared to be no definitive difference in retention of Rb or Cs between seven female genetic carriers of Duchenne dystrophy and five age-matched female controls. Kidney clearance rates for ^{83}Rb and ^{137}Cs were similar in diseased subjects and controls. Findings of distinctive retention patterns, increased excretion, but normal kidney function and normal erythrocyte-to-plasma ratios in diseased persons are consistent with the concept that a cellular defect, resulting in altered membrane permeability in some cells, may account for the enhanced elimination of Rb and Cs in persons with muscular dystrophy. (auth)

15792 INGESTION OF ^{99m}Tc BY ISOTOPE TECHNICIANS. Birks, J. L. (Singleton Hospital, Swansea, Eng.). Brit. J. Radiol.; 46: No. 546, 481(Jun 1973).

The thyroid gland was monitored in a medical technician routinely concerned with elution of a ^{99}Mo–^{99m}Tc generator, and the dispensing and administration of oral doses, as well as performance of scans. On two occasions count rate over the thyroid, measured with a 2 in. dia. NaI crystal scintillation counter, represented a thyroid content of approximately 0.02 μCi ^{99m}Tc. Further investigation showed that ingestion of technetium occurred during the dispensing part of the work rather than in scanning operations. It is suggested that thyroid monitoring should be used as a check on careful working. (UK)

15793 DOSIMETRY OF ^{67}Ga CITRATE IN MAN. Saunders, M. G.; Taylor, D. M.; Trott, N. G. (Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol.; 46: No. 546, 456-463(Jun 1973).

Estimations were made of the absorbed dose to various organs in the human body resulting from the intravenous administration of carrier-free ^{67}Ga-citrate. Observations were made on 19 patients all known to have Hodgkin's disease. Measurements were made of whole-body radioactivity, the activity in blood and, for 11 patients who were undergoing laparotomy, splenectomy, or multiple lymph-node biopsy in tissue specimens. Estimated of the absorbed dose gave values of 0.29, 1.21, 1.87, 1.3 (upper limit), and 0.26 rad/mCi injected to blood, liver, spleen, bone marrow, and whole body respectively. These values were somewhat higher than those reported earlier that were derived from measurements in male August-Marshall hybrid rats. (auth)

15794 DIFFERENTIAL UPTAKE OF $^{125}I^-$ AND $^{99m}TcO_4^-$ IN A HISTOLOGICALLY UNUSUAL METASTATIC THYROID CARCINOMA. Schall, G. L. (National Inst. of Health, Bethesda); Roth, J. A.; Temple, R. J. Surg. Oncol.; 5: No. 3, 235-242(1973).

A case is presented of a histologically unique thyroid carcinoma metastatic to cervical lymph nodes, which concentrated $^{99m}TcO_4^-$ to a significantly greater degree than $^{125}I^-$. This phenomenon may be related to a decreased ability of the tumor to organify iodine, an increased rate of turnover of the iodine-labeled hormone by the tumor, or the unusual angiomatoid pattern of the tumor and the difference in the blood levels of the two tracers at the time of the scans. Hot pertechnetate nodules must be rescanned with radioiodine. (auth)

15795 COMPARISONS BETWEEN THE BIOLOGICAL BEHAVIOR OF CALIFORNIUM AND OTHER TRANSURANIC ELEMENTS. Morin, M.; Nenot, J. C.; Lafuma, J. (CEN, Fontenay-aux Roses, France). Compt. Rend., Ser. D; 276: No. 7, 1209-1211 (12 Feb 1973). (In French).

The metabolism of ^{252}Cf is comparable to that of the transplutonium elements having a valency of III. Its very high diffusion rate after the moment it enters the organism necessitates extensive precautions for its manipulation and urgent therapeutic treatment in the case of accidental contamination. (FR)

15796 ^{131}I THYROID UPTAKES: CAPSULE VERSUS LIQUID. Halpern, S.; Alazraki, N.; Littenberg, R.; Hurwitz, S.; Green, J.; Kunsa, J.; Ashburn, W. (Univ. of California, San Diego, La Jolla). J. Nucl. Med.; 14: No. 7, 507-510(Jul 1973).

Studies were performed that indicate that normal, healthy individuals have a lower thyroidal uptake of ^{131}I following a capsule dose of ^{131}I than they do following a liquid dose. Two possible mechanisms for this are offered, the first being the variable amount of time it takes for the ingested capsule to dissolve completely and the second being the formation of iodine gelatin complexes in the GI tract. In the latter case, the labeled iodine would not appear to be in a form that would allow it to be trapped by the thyroid gland. It is recommended that if early uptake values are important in assessing the clinical state of the patient, liquid ^{131}I be used in preference to capsulized ^{131}I. Furthermore, the possibility exists that the fall in ^{131}I uptake values noted in the past several years may in part be due to the widespread use of ^{131}I capsules. (auth)

Animals

Refer also to abstracts 15580, 15735, and 15835.

15797 (BNWL-1750(Pt.1), pp 21-27) DOSE-EFFECT STUDIES WITH INHALED ^{238}Pu AND ^{239}Pu IN RATS AND DOGS. Ballou, J. E.; Craig, D. K.; Park, J. F.; Ragan, H. A.; Sanders, C. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

To determine life-span dose-effect relationships of inhaled ^{239}Pu and ^{238}Pu, rats and beagle dogs are being exposed to ^{238}Pu and ^{239}Pu oxide, and rats, to ^{238}Pu and ^{239}Pu nitrate. Data are presented on the tissue distribution and retention of the radionuclides at various time intervals. (CH)

15798 (BNWL-1750(Pt.1), pp 35-36) BILIARY EXCRETION OF INJECTED ^{238}Pu IN RATS. Astley, C.; Sanders, C. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Biliary excretion is an important mechanism for clearance of liver Pu. The experimental manipulations used to study biliary excretion in rats were found to influence the tissue distribution and biliary excretion of intraperitoneally injected or ingested ^{238}Pu. (CH)

15799 (BNWL-1750(Pt.1), pp 39-41) DIRECT DETERMINATION OF THE PERCENTAGE TOTAL DEPOSITION OF ^{198}Au-LABELED AEROSOLS INHALED BY BEAGLE DOGS. Craig, D. K.; Decker, J. R.; Herring, J. P. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Design features are described of a two-way valving system to separate expired from inspired air that measures a dog's respiration parameters during aerosol inhalation exposures. Three female beagles were exposed three times to ^{198}Au-labeled gold aerosols (half-life, 2.7 days). Filter paper and cascade impactor samples were used to analyze the inhaled and exhaled aerosol. Activity retained in the dogs was assessed in a thorax counter 2, 8, and 15 to 16 days postexposure. All excreta were collected and analyzed for this period, enabling estimates to be made of both total initial deposition (activity retained + activity excreted) and probable alveolar deposition of inhaled ^{198}Au. Results for the final series of exposures, expressed as a percentage of the measured inhaled activity (total initial deposition + total exhaled activity), are presented. A calculated inhaled activity value close to 100% indicates a good balance of materials between the inhaled and exhaled aerosols. (CH)

15800 (BNWL-1750(Pt.1), pp 43-47) EFFECTS IN HAMSTERS OF LIFE-SPAN INHALATION EXPOSURE TO SIMULATED URANIUM MINE ATMOSPHERES: COMBINATIONS OF Rn DAUGHTERS, U ORE DUST, AND DIESEL ENGINE EXHAUST. Stuart, B. O.; Busch, R. H. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Hamsters are receiving life-time daily 6-hr inhalation exposures to various combinations of Rn daughters, U ore dust, and diesel engine exhaust at levels causing no effects on mortality, body weights, or hematology. Histopathologic examination of tissues has shown the greatest variety of severe pathologic effects in hamsters exposed to 1200 WL Rn daughters with U ore plus diesel exhaust. Invasive squamous cell carcinoma was observed in hamsters receiving 1200 WL Rn daughters with and without uranium ore dust. (auth)

15801 (BNWL-1750(Pt.1), pp 47-49) EFFECTS IN BEAGLE DOGS OF LIFE-SPAN INHALATION EXPOSURE TO SIMULATED URANIUM MINE ATMOSPHERES: COMBINATIONS OF Rn DAUGHTERS, U ORE DUST, AND CIGARETTE SMOKING. Stuart, B. O.; Busch, R. H.; Ragan, H. A.; Hackett, P. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Sixty beagles have now received 39 months of daily inhalation exposures to various combinations of Rn daughters, U ore dust, and cigarette smoking. Higher than control neutrophil and total leukocyte levels in the group exposed to all three insults are the only gross effects noted to date. Histologic changes are seen in the lungs at autopsy. Retention of ^{230}Th was greater than that of ^{234}U in all tissues. (auth)

15802 (BNWL-1750(Pt.1), p 50) COMPARATIVE EFFECTS IN HAMSTERS, RATS, AND MICE OF EXPOSURE TO SIMULATED URANIUM MINE ATMOSPHERES: Rn DAUGHTERS WITH AND WITHOUT U ORE DUST. Palmer, R. F.; Stuart, B. O. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Hamsters, rats, and mice are being chronically exposed to 3000 to 6000 WL of radon daughters with and without uranium ore dust to provide interspecies comparison of the effects of these uranium mine inhalation hazards. (auth)

15803 (BNWL-1750(Pt.1), pp 51-52) CHARACTERIZATION OF ACTUAL AND SIMULATED URANIUM MINE ATMOSPHERES. Cooper, J. A.; Jackson, P. O.; Langford, J. C.; Petersen, M. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Radioactivity versus particle size studies in exposure chambers containing Rn daughters with U ore dust and/or diesel engine exhaust show activity peaks for all Rn daughters at ~0.1 μm. The chamber receiving Rn daughters alone contained up to 30% unattached RaA with high diffusion rates. X-ray fluorescence analyses show Ti, V, Fe, Cu, Zn, Pb, and U at levels ranging from 0.06% to 2.5% in airborne U ore in chambers and mines. High molecular weight polycyclic hydrocarbons correlate closely with soot loading at different size levels. (auth)

15804 (BNWL-1750(Pt.1), pp 53-54) DIAGNOSIS OF ^{147}Pm INHALATION HAZARD IN MAN: PRELIMINARY STUDIES IN RATS. Nelson, I. C.; Shipler, D. B.; Ballou, J. E.; Griffin, B. I. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The use of ^{143}Pm as a substitute for ^{147}Pm in inhalation hazards studies seems feasible, providing a suitable carrier can be found which will provide the necessary mass and which will behave in the body like Pm. Samarium has been proposed as such a carrier and experiments comparing the behavior of intravenously injected and inhaled Sm and Pm in rats were reported previously. The results of these rat studies indicate that, for a reasonable time after exposure, Sm is suitable as a carrier for Pm. If similar results are obtained in dogs, plans will be made for the exposure of human volunteers. (CH)

15805 (BNWL-1750(Pt.1), pp 55-56) PATHOLOGIC EFFECTS OF INHALED DTPA IN HAMSTERS AND RATS. Ballou, J. E.; Busch, R. H.; Craig, D. K.; Smith, V. H. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

With the possible exception of a transient emphysema, no pathology was observed in rats or hamsters attributable to inhaled $CaNa_3$-DTPA at absorbed doses of 1 to 10 times the customary dose used for removal of internally deposited radionuclides. (CH)

15806 (BNWL-1750(Pt.1), pp 57-58) DISTRIBUTION AND RETENTION OF INHALED ^{14}C-LABELED EDTA IN RATS. Smith, V. H. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The rate of appearance in rat urine of inhaled $CaNa_2$-EDTA is retarded compared with intravenously administered EDTA. Assuming that urinary excretion mimics blood levels, inhaled chelating agents should be available for metal decorporation over longer time periods than injected chelating agents. Results are reported from studies with ^{14}C-labeled DTPA that were carried out to obtain data on its translocation and clearance following inhalation or injection. (CH)

15807 (BNWL-1750(Pt.1), pp 58-59) LONG-TERM EFFECTS OF DTPA TREATMENT OF INHALED PLUTONIUM DEPOSITION IN RATS. Ballou, J. E. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Delayed DTPA inhalation administered 20 days after inhalation of aerosols of $^{239}Pu(NO_3)_4$ decreased the body burden of Pu in rats to about one-half the sham-treated control value. (auth)

15808 (BNWL-1750(Pt.1), pp 59-60) EFFECT OF FASTING ON REMOVAL OF INJECTED $^{239}PuO_2$ BY DTPA. Sanders, C. L. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Metabolic alterations due to fasting had no effect on the deposition of $^{239}PuO_2$ injected intraperitoneally in rats, or on decorporation of Pu with DTPA. (auth)

15809 (BNWL-1750(Pt.1), pp 60-61) DTPA-ENHANCED ^{239}Pu EXCRETION VIA THE BILE. Sullivan, M. F. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

Administration of DTPA enhanced the biliary excretion of both monomeric and polymeric ^{239}Pu in rats. It was almost twice as effective for monomeric. (auth)

15810 (BNWL-1750(Pt.1), pp 62-63) CHELATABILITY OF PLUTONIUM IN BLOOD BY DTPA. Ballou, J. E. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The fraction of Pu susceptible to chelation by DTPA in whole blood of dogs remained fairly constant for about 3 hr after injection. In separated plasma or serum, Pu rapidly became less available, suggesting the involvement of formed elements of blood. (auth)

15811 (BNWL-1750(Pt.1), pp 64-65) REMOVAL OF INHALED $^{239}PuO_2$ FROM RAT LUNG BY PULMONARY LAVAGE. McDonald, K. E. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

The removal of inhaled $^{239}PuO_2$ from the rat lung during a single lavage session was improved by the use of hypertonic solutions of NaCl or Triton X-100 detergent. Little lung pathology was noted in dogs ascribable to 19 weekly lavage sessions. (auth)

15812 (LF-tr-79) RADIATION INJURY CAUSED BY CERIUM-144 IN DOGS, RABBITS, RATS, AND MICE. Strel'tsova, V. N.; Moskalev, Yu. I. [nd]. Translated from pp 224-236 of Raspredelenie Biologicheskoy Deistvie i Migratsiya Radioaktivnykh Izotopov, 1961. 24p. Dep. NTIS $3.25.

Cerium-144-labeled cerium chloride was administered intraperitoneally to mice and intravenously to rats, dogs, and rabbits and effects on life span, weight, hematology, and pathology were studied. Dogs were 12 to 15 times more sensitive than mice or rats and rabbits were 5 to 7 times more sensitive than mice or rats. The hemorrhagic syndrome was much more pronounced in rats and mice than in rabbits and dogs. Cirrhosis and tumors of the liver occurred in all animals. Osteosarcomas developed in 50% of rats and rabbits. (HLW)

15813 COMPARISON OF MONOMERIC AND POLYMERIC PLUTONIUM IN THE DOG AND MOUSE. Baxter, D. W.; Rosenthal, M. W.; Russell, J. J.; Moretti, E.; Chladek, D.; Lindenbaum, A. (Argonne National Lab., IL). Radiat. Res.; 54: No. 3, 556-565(Jun 1973).

Monomeric or polymeric plutonium was injected intravenously into beagles and CF#1 mice for the purpose of comparing total-body distribution of the two forms of this actinide in these species. Blood clearance rate, intralobar liver distribution, and urinary and fecal excretion were also determined for the dog. Monomeric plutonium was cleared from dog blood less rapidly than polymeric plutonium. During the first 15 min only 20% (vs 90%) had left the circulation. At sacrifice, 6 days postinjection, significantly more monomeric plutonium remained in the blood although the amount of each form was less than 1%. Monomeric plutonium was deposited chiefly in liver and skeleton of both species. Polymeric plutonium was deposited in liver, spleen, and lungs, with a comparatively small amount deposited in the skeleton. Autoradiographic measurements of plutonium deposition within the dog liver lobe showed a relatively homogeneous distribution of monomeric plutonium, whereas polymeric plutonium tended to be associated with sinusoidal (phagocytic) cells at the center of the liver lobe. The roles of phagocytosis and protein binding in plutonium transport and retention, with possible implications for man, are discussed. (auth)

15814 PRODUCTION OF ^{73}Se IN CYCLOTRON AND ITS UPTAKE IN TUMORS OF MICE. Hara, T.; Tilbury, R. S.; Freed, B. R.; Woodard, H. Q.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 377-384(Jul 1973).

Selenium-73 was produced in a cyclotron by irradiation of germanium with ^{3}He. Four to 8 mCi were obtained by 2-h bombardment with a 20-μA beam. Carrier-free selenate and selenite were prepared by chemical processing. Distribution of this isotope was studied in normal and tumor-bearing mice. Various tumor types took up the radioselenium slowly and continuously in contrast to rapid clearance of the activity from most normal organs. Incorporation of selenium in association with protein and chondroitin sulfate synthesis in vivo was suggested. (auth)

15815 PREPARATION OF CARRIER-FREE ^{47}Sc BY CHEMICAL SEPARATION FROM ^{47}Ca AND ITS DISTRIBUTION IN TUMOR BEARING MICE. Hara, T.; Freed, B. R. (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 373-376(Jul 1973).

Scandium-47, the first decay product of ^{47}Ca, was isolated chemically in a carrier-free form. This was injected intravenously into mice bearing Ehrlich solid carcinoma and its distribution in various tissues was determined by in vitro radioassay using a well type scintillation counter. High uptake was observed in bone, tumor, liver, spleen, kidney, in that order. The tumor/liver ratio at 12 h after injection was 1.1. Autoradiography demonstrated that the outstanding uptake in bone was due to the concentration of scandium in the marrow. A potential utility of ^{47}Sc as a tumor or bone marrow scanning agent is suggested. (auth)

15816 ISOTOPIC METHODS IN THE STUDY OF IMMUNITY TO GASTRO-INTESTINAL HELMINTHS. Henney, R. W.; MacLean, J. M.; Mulligan, W. (Univ. of Glasgow). pp 3-10 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

The uptake by Nippostrongylus brasiliensis of ^{32}P-labelled inorganic phosphate and ^{75}Se-labelled selenomethionine from the host's tissue fluids was measured at different stages of the infection. It was found that such uptake declined rapidly from day 7 of the infection onward. Worms showing lowered uptake were able to recover when transferred surgically to a fresh rat, the extent of recovery depending on the length of sojourn in the original host. The results imply a significant interference with the parasites' metabolism several days before expulsion occurs. (auth)

15817 ACCUMULATION OF STRONTIUM AND CALCIUM IN FRESHWATER FISHES OF JAPAN. Suzuki, Y.; Nakamura, R.; Ueda, T. (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 13: No. 4, 199-207(Dec 1972).

The ^{90}Sr contents in bones of freshwater fishes (carp and gibel) due to radioactive fallout were investigated in relation to those in the surrounding waters from 1963 to 1970. The specific activities (^{90}Sr/Sr) in fish bones and in the surrounding waters decreased rapidly from 1963 to 1964, followed by a gradual decrease from 1964 to 1970. The specific activities in fish bones were always slightly higher than those in the waters, except that in gibel in 1963. The time lag between Sr specific activities in fish bones and those in surrounding waters was 270 days for carp and 360 days for gibel. The discrimination between stable Sr and Ca in freshwater fishes was demonstrated. In the field studies, the Sr–Ca observed ratio (OR) was determined as 0.74 ± 0.05 for carp and 0.84 ± 0.07 for gibel, respectively. In rearing experiments, the Sr accumulation of carp reared in the water of 2×10^{-1} mg Ca/l was twice as much as that in water of 2×10^{2} mg Ca/l. It is now possible to estimate ^{90}Sr content in the bones of carp and gibel by using their OR values and the time lag between Sr specific activities in the freshwater fish bone and the surrounding water. (auth)

15818 ISKUSSTVENNYE I ESTESTVENNYE RADIONUKLIDY V ZHIZNI GIDROBIONTOV. (Artificial and Natural Radionuclides in the Life of Hydrobionts). Tsytsugina, V.G.; Pisik, N. S.; Lazorenko, G. E. Kiev; Naukova Dumka (1973). 152p.

The cytology and radiation cytogenetics of marine fishes and the accumulation and distribution of uranium in marine organisms are reviewed in this monograph. The mechanism of uptake of radionuclides by aquatic life from sea water is discussed relative to the structure and ion exchange properties of alginic acid and alginates. 440 references. (KSW)

15819 CONSEQUENCES OF NUTRITIONAL OBESITY ON THYROID TISSUE. Comsa, J. (Saarland Univ. Medical School, Hamburg). Proc. Soc. Exp. Biol. Med.; 143: No. 3, 792-796 (Jul 1973).

Nutritional obesity was obtained in rats by ad libitum overeating of a simple diet. In these animals, feeding a less rich food resulted in a quick loss of their increased fat content. By selection a strain of rats could be obtained which increase their fat content to amounts exceptional in the original strain, and are less able to lose their increased fat content when subjected to the slimming diet. In obese animals the ^{131}I uptake of the thyroid was conspicuously decreased during the fattening period, nor did it increase when the animals were subjected to the slimming diet. Observations on thyroid activity and histology parallel those previously made on the anterior pituitary histology of the same rats. (auth)

15820 EFFECT OF DIETARY SELENIUM ON ^{75}Se BINDING TO RAT PLASMA PROTEINS. Burk, R. F. (Fitzsimons Medical Center, Denver). Proc. Soc. Exp. Biol. Med.; 143: No. 3, 719-722(Jul 1973).

Two peaks of protein-bound ^{75}Se are seen on the gel filtration chromatogram of rat plasma when the rat has been fed a 0.5 ppm selenium diet and no NaCl is added to the Tris–HCl elution buffer. One of those peaks is absent from the plasma of rats fed a very low selenium diet. Polyacrylamide gel electrophoresis of the ^{75}Se peaks suggests that each may have more than one protein component. Dialysis studies indicate that the ^{75}Se is not in the form of selenotrisulfides. (auth)

15821 ACCUMULATION OF ^{35}S-THIOURACIL BY THE RAT THYROID GLAND. Lees, J.; Alexander, W. D.; Marchant, B. (Gardiner Inst., Glasgow). Endocrinology; 93: No. 1, 162-171 (Jul 1973).

Large and small doses of ^{35}S-thiouracil were administered ip to 2 groups of rats and the distribution and metabolism of ^{35}S-radioactivity in the thyroid and plasma studied for 48 hr. With both doses, significant thyroid to plasma ratios ratios >1 were obtained for both total ^{35}S-radioactivity and residual unmetabolized ^{35}S-thiouracil. However, with the smaller dose, the accumulation of the ^{35}S-label was much more rapid and higher thyroid to plasma ^{35}S-ratios were obtained throughout. These results suggested that the accumulation of thiouracil by the thyroid is dose dependent. Five ^{35}S-compounds were found in the thyroid by thin-layer chromatography; protein-bound radioactivity, sulfate, two unknown compounds, and unmetabolized thiouracil. Similar ^{35}S-compounds were found in the plasma. (auth)

15822 HOMEOSTATIC REGULATION OF ZINC ABSORPTION IN THE RAT. Evans, G. W.; Grace, C. I.; Hahn, C. (Dept. of Agriculture, Grand Forks, ND). Proc. Soc. Exp. Biol. Med.; 143: No. 3, 723-725(Jul 1973).

Zinc concentration of the intestine, zinc-65 uptake by the intestine and zinc-65 absorption were measured in control and zinc-deficient rats. As zinc deficiency progressed, zinc concentration of the intestinal mucosa decreased whereas both the amount of zinc-65 taken up by the mucosa and the absorption of the isotope increased. In addition, zinc concentration of the plasma was decreased in zinc-deficient animals. When zinc-deficient rats were injected with $ZnCl_2$ prior to oral administration of zinc-65, the zinc concentration of both the plasma and the intestine increased and there was a concomitant decrease in both zinc-65 uptake by the intestine and absorption of the isotope. The results of these experiments suggest that zinc absorption is regulated, in part, by the zinc content of the intestinal mucosa which, in turn, is regulated by the zinc content of the plasma. (auth)

New Tracer Techniques

Refer also to abstracts 15236, 15754, and 17785.

15823 METABOLISM OF LABELED PARATHYROID HORMONE. I. Preparation of Biologically Active ^{125}I-Labeled Parathyroid Hormone. Sammon, P. J.; Brand, J. S.; Neuman, W. F.; Raisz, L. G. (Univ. of Rochester, New York). Endocrinology; 92: No. 6, 1596-1603(Jun 1973).

By modification of an electrolysis procedure for the iodination of proteins (controlled voltage to prevent oxidation), it was found possible to produce a highly radioactive ^{125}I-labeled parathyroid hormone with ease and good yield. The labeled hormone was found to be at least 95% homogeneous by chromatoelectrophoresis, density gradient ultracentrifugation, gel filtration, and acrylamide gel electrophoresis. Moreover, by these last three techniques the labeled hormone was found to be indistinguishable from the hormone used as starting material. The labeled hormone was tested by three established bioassay procedures involving liver mitochondria, embryonic rat bone in tissue culture, and mobilization of calcium from bone in thyroparathyroidectomized rats. With all three assays, the labeled hormone was identical to untreated hormone within experimental error. The extent and nature of the iodination is such that it can be concluded that hormone molecules so labeled have undergone no measurable loss in biological activity. Therefore, the tagged hormone produced by this procedure should be a valid marker for the study of the metabolism of the hormone. (auth)

15824 UTILIZATION OF COMMERCIAL TISSUE SOLUBILIZERS IN LIQUID SCINTILLATION COUNTING. Wetter, L. R.; Dyck, J. (National Research Council, Saskatoon, Saskatchewan). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 430-431(Jul 1973).

Recently Dunn (Int. J. Appl. Radiat. Isotopes; 22: 212 (1971)) tested three commercial solubilizers, used to solubilize biological materials, for scintillation counting and found that the color-quenching was so severe with certain fluors that the solubilizers could not be used. The present work however reports that the solubilizers used previously, i.e., Hyamine 10-X, Soluene-100, and NCS can be successfully counted under normal laboratory conditions except when the solvent Triton X-100 is employed with the scintillator BBOT. (UK)

15825 DISCRIMINATION BETWEEN Rb AND K IONS IN THEIR ABSORPTION BY RICE ROOTS. Kannan, S.; Ramani, S. (Bhabha Atomic Research Centre, Bombay). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 431-432(Jul 1973).

It has been stated that certain closely related ions like Rb and K can hardly be distinguished in their absorption by plant cells provided sufficient Ca, which is required for the maintenance of the functional integrity of the cell membranes, is present in the absorption medium. However the studies reported here indicate that even in the presence of Ca rice roots differentially absorb Rb and K. Therefore the use of ^{86}Rb as a tracer for K in ion uptake studies should be viewed with caution. The results further emphasize the need for preliminary evaluation of the technique of labeling K with ^{86}Rb, when different experimental tissues are employed. (UK)

15826 COLLOIDAL COMPOSITION USEFUL AS VEHICLE FOR DIAGNOSTIC RADIOISOTOPES. Pirtle, O. L. Jr. U. S. Patent 3,736,262. 29 May 1973. Filed date 28 Jan 1969. 6p.

A composition useful as a vehicle for diagnostic radioisotopes was developed. The colloidal composition results from mixing at elevated temperatures, water, an antimony salt of a polyhydroxy acid, and ammonium sulfide. The diagnostic radioisotope is dispersed in the colloidal composition and adsorbed by the particles of the colloidal composition. (Official Gazette)

15827 IODINATION OF RIBOSOMAL RNA IN VITRO. Heiniger, H. J.; Chen, H. W.; Commerford, S. L. (Jackson Lab., Bar Harbor, ME). Int. J. Appl. Radiat. Isotop.; 24: No. 7, 425-427(Jul 1973).

It is shown that ribosomal RNA can easily be iodinated in vitro without degradation to small polynucleotide pieces. The reaction is specific, i.e., the label is bound stably and depending upon the iodine isotope chosen the iodinated RNA(s) can be analyzed by γ-counting, liquid scintillation counting, or high-resolution autoradiography. Double labeled molecules can readily be obtained by pre-labeling RNA with ^{3}H, ^{14}C, or other isotopes before iodination and used for investigations of polynucleotide metabolism. Besides rRNA, 70S C-type murine viral RNA, to be used in hybridization with mouse chromosomal preparations, has also been iodinated. (UK)

15828 RADIOIMMUNOASSAY OF RHESUS MONKEY FOLLICLE STIMULATING HORMONE (RhFSH). Yamaji, T.; Peckham, W. D.; Atkinson, L. E.; Dierschke, D. J.; Knobil, E. (Univ. of Pittsburgh School of Medicine). Endocrinology; 92: No. 6, 1652-1659(Jun 1973).

Two radioimmunoassays for the measurement of rhesus monkey (Macaca mulatta) follicle stimulating hormone (RhFSH) were developed. A purified RhFSH preparation with a biological potency of 200 U/mg is utilized as trace in both assays following its iodination with ^{131}I. One of the systems, the homologous assay, employs antiserum from a guinea pig that was immunized with a crude glycoprotein preparation from rhesus monkey pituitary glands. After absorption of this antiserum with purified rhesus monkey thyroid stimulating hormone (RhTSH), the homologous assay is specific for RhFSH. In the other system, the heterologous assay, either of two antisera to human FSH (anti-hFSH) can be utilized. This assay is specific for both RhFSH and its β subunit. The sensitivities of both assays are sufficient to measure circulating FSH at all phases of most normal menstrual cycles in the rhesus monkey. (auth)

15829 PREPARATION AND PROPERTIES OF ^{125}I-LH-RH. Yukitaka, M.; Chrambach, A.; Mecklenburg, R.; Lipsett, M. B. (National Inst. of Health, Bethesda, MD). Endocrinology; 92: No. 6, 1725-1730(Jun 1973).

Synthetic LH-RH was iodinated with ^{125}I by the lactoperoxidase technique. The product was separated from non-iodinated LH-RH by polyacrylamide gel electrophoresis, identified as the monoiodo-derivative, and shown to retain biologic activity. Iodinated oligomers of LH-RH were also separated. (auth)

15830 PREPARATION AND SPECIFICITY OF ANTISERUM TO SYNTHETIC SECRETIN AND ITS USE IN A RADIOIMMUNOASSAY (RIA). Boden, G.; Chey, W. Y. (Temple Univ. Health Science Center, Philadelphia). Endocrinology; 92: No. 6, 1617-1624(Jun 1973).

Secretin antibodies were produced in rabbits by immunization with synthetic secretin coupled to bovine serum albumin. An antiserum was obtained that reacted with similar strength with the complete secretin molecule and the C terminal tricosapeptide (residues 5 through 27) to a lesser extent (50%), with the C terminal tetradecapeptide (residues 14 through 27), and only minimally (0.03%) with the N-terminal tetradecapeptide (residues 1 through 14). Insulin, human growth hormone, ACTH, FSH, LH, glucagon, and gastrin I did not react with the antibody. Natural cholecystokinin-pancreozymin crossreacted weakly (0.03%) probably as a result of contamination with secretin. Using this antiserum and ^{125}I-labeled secretin of high specific activity, a sensitive and specific radioimmunoassay for the measurement of secretin was developed. Sensitivity of the assay was 25 pg. Coefficients of variation of intra and interassay reproducibility were 9.4% and 17.1%, respectively. Mean fasting serum immunoreactive secretin (IRS) level of 39 healthy males and females was 1.87 ± 0.60 (SD) mU per ml. Perhipheral venous IRS rose 60%, 510%, and 320% respectively in three experiments with two volunteers following intraduodenal HCl administration. (auth)

15831 RADIOIMMUNOASSAY OF OVINE DICTYOCAULIASIS. Movsesijan, M.; Lalic, R. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Belgrade). pp 33-42 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Immunoglobulin from lambs infected with Dictyocaulus filaria and anti-sheep gamma globulins were isotopically labelled. Juvenile stages of D. filaria 12-14-days-old served as antigen in this immunological test. The method proved to be suitable for detecting specific antibodies against D. filaria. In several sera of lambs artificially infected with D. filaria specific antibodies were detected. Using the radioactively labelled anti-gamma globulins it was possible to estimate quantitatively the level of antibodies in the circulation of infected animals. Immunoglobulins separated from sera of normal lambs did not combine specifically with antigens of D. filaria. (auth)

15832 EFFECT OF ASCARIDIA GALLI ON PROTEIN AND ELECTROLYTE ABSORPTION FROM CHICKEN INTESTINES. Hurwitz, S.; Shamir, N.; Bar, A. (Volcani Inst. of Agricultural Research, Bet-Dagan, Israel). pp 61-65 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Absorption and digestion of protein and absorption of phosphate were estimated in chicks infected with the adult stage of Ascaridia

galli, with the aid of ^{91}Y as a non-absorbable reference substance. Compared with non-infected chicks, the infected ones exhibited a larger secretion of both nitrogen and phosphate into the duodenum, the former resulting in a reduced percentage of apparent protein digestion. Increased rates of absorption and digestion in the infected chicks further down the gastro-intestinal tract fully compensated for reduced apparent nitrogen digestion and absorption, and resulted in a higher rate of phosphate absorption. (auth)

15833 USE OF RADIOISOTOPES TO DETECT ANTIGEN-ANTIBODY INTERACTIONS IN HELMINTHIC INFECTIONS. Sadun, E. H.; Williams, J. S.; Gore, R. W. (Walter Reed Army Medical Center, Washington, DC). pp 73-90 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

A radioactive iodine-labelled microprecipitin (RAMP) assay was developed for measuring the binding of antigen by antibody in schistosomiasis and trichinosis. The technique, which is relatively rapid and highly reproducible, requires very little antigen because of its extreme sensitivity. Heating of immune sera resulted in a marked decrease in binding activity. Antigen binding did not depend upon complement. Reduction and alkylation lowered considerably the reactivity of the sera in this test. Comparison of the results of this assay with those obtained with conventional tests indicated that primarily antibodies in the IgE immunoglobulin class are measured. A marked similarity of results was observed between the RAMP assay and the passive cutaneous anaphylactic tests. Conversely, no obvious correlation was observed between results of the RAMP assay and conventional tests. Absorption of immune rabbit serum with antirabbit IgE serum completely removed PCA activity and reduced the antigen binding activity of this assay but failed to decrease fluorescent antibody titres. The present investigations indicate that this assay can be used effectively to measure antibodies in the IgE class, thus providing highly reproducible sensitive in vitro tests for the detection and quantitation of reaginic antibodies in at least two important helminthic infections. (auth)

15834 POSSIBLE TECHNIQUE FOR THE QUANTITATIVE ASSAY OF INFECTIVE PARTICLES OF THEILERIA PARVA. Purnell, R. E.; Sansom, B. F.; Sellwood, S. A. (Agricultural Research Council Inst. for Research on Animal Diseases, Compton, Eng.). pp 161-163 of Isotopes and Radiation in Parasitology III. Vienna; International Atomic Energy Agency (1973).

From isotopes and radiation in parasitology III meeting; Kabete, Kenya (22 Nov 1971). See STI/PUB-328; CONF-711153-.

Ticks, Rhipicephalus appendiculatus, were infected with Theileria parva, the causative agent of East Coast fever of cattle. Infected and uninfected ticks were fed on ears of rabbits and calf serum labeled with ^{3}H-thymidine was fed to the ticks. Calf serum was later collected from the ticks and filtered through a Millipore filter. Results of liquid scintillation counting showed that the count rate of infected ticks was higher than that of uninfected ticks. It is suggested that the technique could be developed to estimate the concentration of infective particles of T. parva in tick-derived material. (HLW)

15835 ERROR IN ESTIMATION OF CONTAINED MILK VOLUME IN THE DAIRY GOAT WITH CERIUM-141. Sagan, C. E.; Snipes, M. B.; Lengemann, F. W. (Cornell Univ., Ithaca, NY). J. Dairy Sci.; 56: No. 7, 935-938(Jul 1973).

Cerium-141 as a nonabsorbable radiomarker was used in nine separate trials with two goats to determine milk volume by isotopic dilution techniques. A correction procedure, developed for guinea pigs, showed an average underestimate of contained milk volume of 1.1% (range, 0.61 to 4.06%) for goats having from 353 to 1,202 ml of milk per udder half. A correction for incomplete penetration of cerium-141 into the alveolar spaces of the mammary gland is not needed in the goat. (auth)

15836 DUAL-ISOTOPE METHOD FOR DIAGNOSIS OF INTRACARDIAC SHUNTS. Bosnjakovic, V. B.; Bennett, L. R.; Greenfield, L. D.; Vincent, W. R. (Univ. of California, Los Angeles). Contract AT(04-1)GEN-12. J. Nucl. Med.; 14: No. 7, 514-521(Jul 1973).

Dual-isotope (^{133}Xe in saline, ^{99m}Tc-sulfur colloid) angiocardiography is a simple, inexpensive technique for diagnosing intracardiac shunts. The technique requires only a single venipuncture, is without risk to the patient, and detailed evaluation of the study can be performed without the patient being present. This method will permit reliable noninvasive screening for diagnosis of intracardiac shunts of hemodynamic and surgical significance. Twenty-five patients were studied: 7 without shunts, 4 with right-to-left shunts, and 14 with left-to-right shunts. No false-positives were encountered in the normals, and all patients with shunts, except three with left-to-right shunts, were diagnosed by the dual-isotope technique. (auth)

15837 RADIONUCLIDE VENOGRAPHY. McDonald, G. B.; Hamilton, G. W.; Barnes, R. W.; Rudd, T. G.; Strandness, D. E.; Nelp, W. B. (Veterans Administration Hospital, Seattle). J. Nucl. Med.; 14: No. 7, 528-530(Jul 1973).

A technique for radionuclide venography of the legs and pelvis using $^{99m}TcO_4$ is described. Results in 37 patients without and in 40 patients with occlusive venous disease are presented. The method is simple, well tolerated, and correlates well with Doppler flow studies of the venous system. (auth)

15838 EXCESS EXTRAHEPATIC UPTAKE OF RADIOCOLLOID ASSOCIATED WITH LIVER ABSCESSES. Gates, G. F.; Gwinn, J. L.; Lee, F. A.; Payne, V. C. Jr. (Children's Hospital of Los Angeles). J. Nucl. Med.; 14: No. 7, 537-540(Jul 1973).

A 12-year-old boy with multiple pyogenic liver abscesses had increased extrahepatic accumulation of ^{99m}Tc-sulfur colloid. After surgical drainage and 2 weeks of antibiotic therapy, the cirrhosis-like scan image was reversible. (auth)

15839 RECOGNITION OF HEPATITIS B ANTIGEN DETERMINANTS BY A DOUBLE LABEL RADIOIMMUNOASSAY: A SENSITIVE MEANS OF SUBTYPING HEPATITIS B ANTIGEN. Aach, R. D.; Hacker, E. J.; Parker, C. W. (Washington Univ., St. Louis). J. Immunol.; 3: No. 2, 381-388(Aug 1973).

A sensitive radioimmunoassay is described for subtyping hepatitis B antigen (HB Ag) in human serum. The method utilizes antisera (HB Ab), prepared in immunized guinea pigs, which contain predominantly anti-d or anti-y antibodies, and radioiodinated HB Ag of either D or Y subtype. Sera with HB Ag of subtype D (D) were strongly positive by RIA, employing anti-d HB Ab and ^{125}I-HB Ag (D), whereas specimens with HB Ag of Y subtype were negative or only weakly positive. Converse results were observed when antigenemic sera were evaluated by RIA with anti-y HB Ab and ^{125}I Y. By combining guinea pig HB Ab possessing high-titered anti-d and anti-y with ^{131}I D and ^{125}I Y, it was possible to screen for and subtype HB Ag simultaneously. One hundred and five antigenemic sera were evaluated; 93 or 88% could be readily subtyped by the combined RIA, including 31 of 43 samples with HB Ag in amounts too low to be detected by agar gel diffusion (AGD) or counter immunoelectrophoresis (CEP). Subtype D-HB Ag was found primarily in the serum of blood donors and patients with posttransfusion hepatitis, whereas subtype Y antigen predominated in individuals whose hepatitis was associated with the illicit use of drugs. Samples showing only "a" specificity by AGD also possessed "d" or "y" determinants by RIA. The relative antigenic reactivity of "a" and "d", or "a" and "y" determinants appeared to vary in different specimens. This could not be explained simply by the HB Ag subtype or the number of particles in the specimens evaluated. (auth)

15840 ABSENCE OF AGLOMERULAR BLOOD FLOW DURING RENAL VASODILATATION AND HEMORRHAGE IN THE DOG. O'Dorisio, T. M.; Stein, J. H.; Osgood, R. W.; Ferris, T. F. (Ohio State Univ., Columbus). Proc. Soc. Exp. Biol. Med.; 143: No. 3, 612-615(Jul 1973).

The radioactive microsphere method was used to quantitate aglomerular blood flow during intrarenal acetylcholine administration (6 studies) and hemorrhagic hypotension (5 studies). In each of the 11 studies, less than 1% of the injected radioactivity was recovered in renal venous effluent. These findings strongly suggest that a significant diversion of renal blood flow by a non-glomerular pathway does not occur in these two models. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 15271, 15940, 15941, 15947, 15953, 15956, 15963, 15964, 15966, 15993, 16070, 16080, 16098, 17352, 17376, 17394, 17422, 17425, 17494, 17610, 17611, 17752, 17779, 17808, and 17814.

15841 (AGARD-CP-120, pp 295-309) PROSPECTS FOR OXIDATION-RESISTANT REFRACTORY COMPOUNDS. Tallan, N. M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). 1973.

From specialist meeting on high temperature corrosion of aerospace alloys; Lyngby, Denmark (10 Apr 1972).

Many of the refractory compounds, especially the borides, carbides, and nitrides of silicon and the group IVB, VB, and VIB elements, offer attractive potential as future high-strength, high-temperature materials. Full realization of that potential, however, requires thorough understanding of their properties over a wide range of temperatures, ambient environments and stress states. Recent results of static and dynamic oxidation studies of the more promising of these materials, those combining optimum resistance to corrosion, thermal shock, fracture, fatigue, etc., are presented. Particular attention is directed to the potential of such materials as ZrB_2, HfB_2, SiC, Si_3N_4 and their combinations in a range of technologically important applications, including gas turbines, hypersonic and re-entry vehicles. Where possible, relation of the details of the oxidation processes, their dependence on fabrication variables, and their effect on material performance is emphasized. The possible use of these and related high-temperature materials as coatings for refractory metals and alloys is discussed. (auth)

15842 (COO-3344-9) BASIC RESEARCH IN CRYSTALLINE AND NONCRYSTALLINE CERAMIC SYSTEMS. Kingery, W. D.; Coble, R. L. (Massachusetts Inst. of Tech., Cambridge). 1972. Contract AT(11-1)-3344. 51p. Dep. NTIS $4.75.

Research is reported in the following fields: kinetics of phase changes, diffusion, and microstructure development in ceramics; relationship of properties to composition, crystal structure, and microstructure; structure and properties of thin films and noncrystalline solids; and materials synthesis and preparation. Results that were not previously reported or published include: diffusivities and defect structure in doped (Ti) single-crystal Al_2O_3; annealing of UO_{2+x} in thermal gradient; CVD growth of UO_2 crystals using Cl_2; growth of $ZrO_2-Y_2O_3$ single crystals and polycrystals; chemical vapor deposition of ZnS on GaP; chemical vapor deposition of $Co_xNi_{1-x}O$; oxygen permeation rate measurements using calcia-stabilized zirconia; absence of vacancy ordering in $Ce_xY_{1-x}O_{2-y}$; reduction of CeO_2; x-ray topographic characterization of MgO crystals; dislocation behavior in pure and Fe-doped MgO single crystals. (DLC)

15843 (COO – 3344-10) BASIS RESEARCH IN CRYSTALLINE AND NONCRYSTALLINE CERAMIC SYSTEMS. Annual Report. Kingery, W. D.; Voble, R. L. (Massachusetts Inst. of Tech., Cambridge). 1973. Contract AT(11-1)-3344. 65p. Dep. NTIS $5.25.

Studies covered: (1) kinetics of phase changes, diffusion, and microstructure development, (2) relationship of properties to composition, crystal structure, and (3) materials synthesis and preparation. New, previously unreported results are given on: thermal gradient studies on UO_2 and UO_2-CeO_2; growth of UO_2 single crystals by chemical vapor transport using Cl_2; review and analysis of ambipolar diffusion; defect structures in Al_2O_3; microstructural evolutions of two-phase Vycor glass-type (6% Na_2O, 25% B_2O_3, 67.8% SiO_2) at 560 to 720°C; electric conductivity of amorphous Si after annealing; grain-boundary sliding in Al_2O_3 and other oxides; plausible concepts necessary and sufficient for interpretation of ceramic grain boundary phenomena; electric charges on grain boundaries in NaCl and oxides; solute-vacancy pair formation for ZrO_2 in MgO; and grain-boundary segragation and precipitation in Nd-doped Yttralox. (32 references) (DLC)

15844 (LA-UR-73-769) VAPORIZATION BEHAVIOR OF THE ZIRCONIUM–URANIUM–CARBON SYSTEM. Storms, E. K. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 16p. (CONF-730909-1). Dep. NTIS $3.00.

From sixth international mass spectrometry conference; Edinburgh, Scotland, UK (10 Sep 1973).

A mass spectrometer was used to measure the pressures of Zr and U over various ternary compositions by Knudsen effusion. Relative U activities were determined for 11 samples (compared to ternary), and absolute U activities were determined for 3 samples. The relative U activity of $U_x\ Zr_{1-x}\ C + C$ follows the equation $Ra_U = (2.3x + 10\ x^2)\ \exp-(1.04 \cdot 10^4 - 4.026 \cdot 10^4 x)\ (1/T - {}^1/_{2300})$ between 1900 and 2400°K. The Zr activity in the ternary was calculated by three methods. The free energy of mixing and the interaction energy were calculated. 4 tables, 2 figures, 15 references. (DLC)

15845 (NAA-SR-11728) STRENGTH PROPERTIES OF SNAP FUEL MATERIALS UNDER HYDROGEN-LOSS CONDITIONS. Berling, J. T.; Culley, G. E. (Atomics International, Canoga Park, Calif.). 25 Aug 1966. Contract AT(11-1)-GEN-8. 24p. Dep. NTIS $3.25.

Declassified 17 Apr 1973.

Tests were made to determine the strength properties of SNAP fuel material at hydride compositions near and in the $\beta-\delta$ equilibrium range. This information is of interest in evaluating the performance of a SNAP reactor that has lost sufficient hydrogen to produce β-phase material. A tensile creep test was conducted at 1300°F on SNAP fuel as the hydrogen composition was decreased from the starting δ-phase composition (1.52 H/Zr) to a composition within the two-phase $\beta + \delta$ region (~1.33 H/Zr). The $\beta + \delta$ phase composition exhibited the highest creep rate, and an average minimum creep rate which was 120 times the rate obtained for δ-phase material. Two short-term tensile tests were also conducted on hydrided SNAP fuel specimens, subjected to a temperature gradient (range, 1340 to 1400°F) which produced segregation of the β and δ phases, to determine the strength of the $\beta-\delta$ interface, relative to the strength of either single phase. The longitudinal temperature profile used produced an infinitely small interface between the two phases. Samples did not rupture at this interface, but in the pure β phase, after attaining 32% elongation; and the ultimate tensile strength was approximately one-half that of δ-phase material. (auth)

15846 (ORNL-tr-2663) EQUILIBRIUM PRESSURE OF CARBON MONOXIDE OVER TANTALUM–OXYGEN–CARBON MIXED CRYSTALS. Fromm, E.; Heinkel, O. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.) from Z. Metallk.; 58: No. 11, 805-810(1967). 20p. Dep. NTIS $3.00.

The dependence of the CO equilibrium pressure over tantalum on temperature and the content of dissolved oxygen and carbon was determined between 1700 and 2000°C. The heat of solution of carbon monoxide in tantalum is −65 kcal/mole CO. The experimentally observed dependence on concentration of the CO equilibrium pressure conforms to the relation $p_{CO} \sim c_{CO}^{1.6}$ and thus does not conform exactly to the Sieverts $\sqrt{p}$-law. In the temperature range of the experiments, the terminal solubility of the Ta–C–O solid solution with a Ta/C/O ratio of 1 lies between 0.2 and 0.6 mole % CO. At temperatures above 2000°C, the equilibrium is disturbed by the evaporation of volatile oxides. (auth)

15847 (PWAC-369) CONTROLLED-ATMOSPHERE SINTERING OF URANIUM MONONITRIDE. Craig, R. A.; Miller, A. D.; Darrah, J. G. (Pratt and Whitney Aircraft, Middletown, Conn.). May 1962. Contract AT(30-1)-2789. 31p. Dep. NTIS $3.75.

Declassified 31 May 1973.

A sintering cycle which uses vacuum at low temperature and a nitrogen atmosphere at high temperature for producing dense, single-phase, uranium mononitride is described. This sintering process results in consolidated pellets consistently over 95% of theoretical density and as high as 98% of theoretical, showing that this fuel may be produced by relatively inexpensive means. The synthesis of fine, pure UN powder is described, and the effects of particle size as well as oxygen and carbon impurities during sintering are discussed. (auth)

15848 (SLL-73-5258) EFFECT OF STRUCTURAL RELAXATION ON HELIUM DIFFUSION AND SOLUBILITY IN VITREOUS B_2O_3. Shelby, J. E. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 28p. (CONF-730621-1). Dep. NTIS $3.50.

From 3rd Rolla Materials conference; Baden-Baden, F.R. Germany (June 1973).

Helium permeation, diffusion, and solubility in vitreous B_2O_3 were measured as a function of thermal history and as a function of time at constant temperature. Volume relaxation measurements were also made on similar specimens. The correspondence between the effective relaxation times for gas mobility and molar volume suggests that the changes observed in both properties result from the same changes in the glass structure. This relaxation mechanism is described by the expression $\tau' = 10^{-4} \exp(-18{,}000/RT)$ where τ' is in seconds and the activation energy

is in cal/mole. It is concluded that helium mobility is a function of the molar volume of the glass. (auth)

15849 (TRG-Report-1975) QUANTITATIVE ASSESSMENT OF IRRADIATION CREEP IN UO_2. Anderson, R. G.; Hargreaves, R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). May 1973. 13p. Dep. NTIS (U. S. Sales Only) $3.00. UK 50 pence.

The assumption that irradiation creep exists in UO_2 has been shown to be consistent with a variety of results on hollow pellets deforming under gas pressure, DFR pin swelling, and a number of results from American sources. The current best estimate of creep strength is about fifty-five elastic deflections per 1 at.% burnup. (auth)

15850 MAGNETIC AND THERMAL PROPERTIES OF $Gd(OH)_3$. A. T. Skjeltorp; Catanese, C. A.; Meissner, H. E.; Wolf, W. P. (Yale University, Becton Center, New Haven, Conneticut 06520). Phys. Rev. B 7: No. 5, 2062-2091 (1 Mar 1973).

Measurements of the low-temperature specific heat have shown that $Gd(OH)_3$ undergoes a cooperative transition at 0.94 ± 0.02 K. To determine the interactions giving rise to this transition, a series of accurate susceptibility and magnetic-specific-heat measurements were made at temperatures high compared to the transition, and analyzed using asymptotically exact series expansions. The susceptibility measurements were made using an audiofrequency mutual-inductance method at temperatures between 1.4 and 4.2 K and 14.7 and 20.0 K. The magnetic specific heat was determined using two different techniques. One was the conventional calorimetric method, and measurements were made at temperatures between 0.4 and 15 K. An estimate of the lattice specific heat and a comparison with calorimetric measurements of the diamagnetic isomorph $La(OH)_3$ are given. In the other method, the magnetic specific heat was determined from the field dependence of the adiabatic differential susceptibility, using the method of Casimir and du Pré (CdP). For this, a special 4.5 MHz tunnel-diode oscillator was used, together with a sensitive temperature controller and a superconducting solenoid. Measurements were made in fields up to 15 KOe at temperatures between 5 and 68 K. Using an iterative procedure, the leading terms in the susceptibility expansion were found to be $\chi^{\parallel}_{\infty}=\lambda/(T-\Theta^{\infty}_{\parallel}+B_{2\parallel}/T+B_{3\parallel}/T^2+\ldots)$ with $\lambda=7.815\pm0.008$ emu K/mole, $\theta^{\infty}_{\parallel}=0.02\pm0.10$ K, $B_{2\parallel}=2.05\pm0.10$ K^2, and $B_{3\parallel}=0.59\pm0.10$ K^3, where $\parallel$ denotes measurements parallel to the crystal c axis and the superscript ∞ denotes correction to an infinitely long sample shape. For the magnetic specific heat, the leading terms were found to be $C_M/R=C_2/T^2+C_3/T^3+\ldots$, with $C_2=4.09\pm0.05$ K^2 and $C_3=-4.2\pm0.7$ K^3. The unusually small error in C_2 reflects the fact that the CdP method determines C_MT^2/R directly, without the necessity of first correcting for the much larger lattice specific heat. To analyze for the interactions, the dominant contributions were assumed to be of the Heisenberg form $J_n\vec{S}_0\cdot\vec{S}_n$ with J_n restricted to nearest and next-nearest neighbors, plus the calculated magnetic dipole-dipole coupling summed over all neighbors. These assumptions were tested as part of the analysis and upper limits were obtained for J_3 and for possible anisotropic nondipolar interactions. The analysis was also checked against additional susceptibility measurements perpendicular to the c-axis at temperatures between 1.4 and 4.2 K and magnetization measurements in fields up to 14 kOe at temperatures between 1.1 and 4.2 K. The final results gave $J_1=0.180\pm0.005$ K and $J_2=-0.017\pm0.005$ K, indicating that the system should approximate to an assembly of loosely coupled antiferromagnetic chains, but the situation is complicated by the magnetic dipole interactions which are comparable in strength. To investigate the nature of the ordering, accurate susceptibility measurements were made at temperatures between 0.6 and 1.4 K again using an inductance method. The results were interpreted as characteristic of an antiferromagnet with predominantly but not exclusively nearest-neighbor interactions. The cooperative properties of such a system are difficult to calculate, and even though all the important terms in the microscopic Hamiltonian have been determined, it has not proved possible to predict the precise nature of the ordered state. A number of possible states are discussed which probably approximate to the actual ground state, but further theoretical work on this problem is called for. (auth)

15851 METAL-INSULATOR TRANSITIONS IN PURE AND DOPED V_2O_3. McWhan, D. B.; Menth, A.; Remeika, J. P.; Brinkman, W. F.; Rice, T. M. (Bell Telephone Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. B 7: No. 5, 1920-1931 (1 Mar 1973).

The addition of Ti^{3+} and Mg^{2+} to V_2O_3 leads to the suppression of the antiferromagnetic insulating phase; whereas the addition of Ti^{4+}, Zr^{4+}, and Fe^{3+} results in a first-order transition from a metallic to an insulating state. The effect of impurity ions is discussed in terms of the changes they cause in the bandwidth in analogy with the effect of pressure. The Hall coefficient of metallic V_2O_3 at 4.2 °K and 20 kbar is $R_H=+(3.5\pm0.4)\times10^{-4}$ cm^3/C which is close to the value measured at 150 °K and 1 atm. The residual resistivity of metallic V_2O_3 is strongly impurity dependent (140 μΩ cm/at.% Cr and 35 μΩ cm/at.% Ti). These results are not completely consistent with current theories for the metal-insulator transition in V_2O_3 but the best available model still seems to involve a localized-to-nonlocalized transition within the d band primarily involving orbitals in the basal plane. (auth)

15852 MÖSSBAUER SCATTERING IN $^{141}_{59}$PR. Groves, J. L.; DePasquali, G.; Debrunner, P. G. (Department of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. B 7: No. 5, 1974-1984 (1 Mar 1973).

We have completed a series of Mössbauer scattering experiments on $^{141}_{59}$Pr using an axially symmetric backscattering arrangement. From the relative isomer shifts between Pr^{+4} and Pr^{+3} compounds we estimate that the change in the mean-square charge radius between the 145-keV excited state and ground state of the $^{141}_{59}$Pr nucleus is 1.28×10^{-28} cm^2. PrO_2 exhibits ordered magnetic behavior below 15 K. We estimated the hyperfine fields for the electronic ground states of a Pr^{+4} ion in a magnetic cubic crystal and compared the observed values of the effective fields with the calculated fields. We found the best agreement when we assumed that the exchange field was directed toward a nearest-neighbor Pr^{+4} ion. We obtained (3.1 ± 0.2) μ_N for the magnetic moment of the 145-keV spin 7/2 level of $^{141}_{59}$Pr. (auth)

15853 HALL EFFECT IN VO_2 NEAR THE SEMICONDUCTOR-TO-METAL TRANSITION. Rosevear, W. H.; Paul, W. (Division of Engineering and Applied Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. B 7: No. 5, 2109-2111 (1 Mar 1973).

Hall-effect measurements as a function of temperature have been made on single-crystal samples of VO_2 at temperatures both above and below the semiconductor-to-metal transition temperature; the Hall mobility in the semiconducting phase was approximately 0.5 cm^2/V sec and in the metallic phase approximately 0.35 cm^2/V sec. (auth)

15854 QUANTITATIVE ADHESION TESTS OF VACUUM-DEPOSITED THIN FILMS. Berendsohn, O. (Perkin-Elmer Corp., Danbury, CT). J. Test. Eval.; 1: No. 2, 139-143(Mar 1973).

An apparatus for performing quantitative adhesion tests of vacuum deposited thin films on a routine basis was developed by modification of a microhardness tester. The instrument employs a sapphire stylus which is drawn across the film surface until a critical load is established in one pass. This critical load is defined as the weight, in grams, at which the stylus completely removes the film in the contacted area. A number of critical loads for various metallic and dielectric coatings have been established and are being used to control the reliability of optical coatings. In addition, tests were conducted to determine the highest critical load, that is, the best adhesion possible for a given combination of materials and substrates. Typical values ranged from 25 to 100 g, the upper limit being determined by the cohesive strength of the substrate and the hardness and wear resistance of the stylus. The scribe method appears to be a substantial improvement on the "Scotch Tape" technique in that it yields quantitative adhesion data, and thus can be used to evaluate optimum deposition parameters, detect coatings of questionable quality, and give an early indication of coating deterioration. Deposit materials for which data are given include Ag-Y, Th oxyfluoride, CeO_2, and ZrO_2. (auth)

15855 PHASE ANALYSIS AND ELECTRIC CONDUCTIVITY OF THE SYSTEM $ZrO_2-Sc_2O_3-CaO$. Kotlyar, A. G.; Neuimin, A. D.; Pal'guev, S. F.; Strekalovskii, V. N. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 144-147(1972). (In Russian).

The structure and electric conductivity of a series of sections of the system $ZrO_2-Sc_2O_3-CaO$ were studied. Annealing at 2000°C for one hour of samples with 12 to 26 mole % ($Sc_{1.5}$ + CaO) leads to the formation of solid solutions with a fluorite structure. The electric conductivity of the solid solutions obtained at constant ($Sc_{1.5}$ + CaO) content decreased with added CaO. (tr-auth)

15856 CRYSTALLOCHEMICAL CHARACTERISTICS AND ELECTRIC CONDUCTIVITY OF SOLID SOLUTIONS OF RARE EARTH OXIDES AND HAFNIUM DIOXIDE. Zhidovinova, S. V.; Kotlyar, A. G.; Strekalovskii, V. N.; Pal'guev, S. F. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 148-150(1972). (In Russian).

The electric conductivity and structure of mixed oxides in the system $HfO_2-M_2O_3$ (where M = Y or rare earth elements) were investigated. The electric conductivity of solid solutions of HfO_2 essentially depends on the radius of the cation introduced; it increases when the radium decreases. (tr-auth)

15857 ION AND ELECTRON COMPONENTS OF THE ELECTRIC CONDUCTIVITY OF SAMPLES IN THE $ZrO_2-Nd_2O_3$ SYSTEM. Volchenkova, Z. S. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 138-143(1972). (In Russian).

The temperature coefficients of ion and electron components in the $ZrO_2-Nd_2O_3$ system were determined over the range 500 to 1000°C. The total electric conductivity of samples in this system was measured at 1000°C in atmospheres with different partial

pressures of oxygen. The data are discussed in the light of the known crystal structure of the samples and the theory of ionic crystals with defects. (tr-auth)

15858 THERMODYNAMIC AND METALLOGRAPHIC INVESTIGATIONS OF THE SYSTEM BORON–IRON. Plotnikova, A. F.; Ilyushchenko, N. G.; Anfinogenov, A. I.; Belyaeva, G. I.; Finkel'shtein, S. D. Tr. Inst. Elektrokhim.; Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 112-118(1972). (In Russian).

The thermodynamic properties of the system B–Fe were derived from emf measurements for the concentration range 22.3 to 99.9% at. % B from 1073 to 1173°K. Chemical, metallographic, x-ray, and electronographic methods were utilized to construct the phase diagram of the system. The existence of four regions was established: Fe–Fe_2B, Fe_2B–FeB, FeB–FeB_x, and the solid solution of Fe in B. (tr-auth)

15859 MECHANISM OF GROWTH OF HEMISPHERICAL SEDIMENTS OF URANIUM DIOXIDE AT THE FACE OF AN ELECTRODE. Puzakov, V. V.; Baraboshkin, A. N.; Kaliev, K. A.; Tarasova, K. P. Tr. Inst. Elektrokhim., Ural. Nauch. Tsentr. Akad. Nauk SSSR; No. 18, 99-105(1972). (In Russian).

A previous conclusion reached by these authors regarding the growth of a hemispherical form of UO_2 precipitates at an electrode face was additionally confirmed by their low electric conductivity. The conductivity of electrolytic UO_2 and the diffusion coefficient of UO_2^{2+} ion in a LiCl–KCl melt were considerably less than the corresponding values of the melt. (tr-auth)

15860 CONTACT INTERACTION OF REFRACTORY COMPOUNDS WITH LIQUID METALS. III. Samsonov, G. V.; Panasyuk, A. D.; Borovikova, M. S. (Inst. of Problems of Mathematics, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 61-67(May 1973). (In Russian).

The process of wetting borides of metals from subgroups IVa–VIa of the periodic system with nontransition metals of subgroups Ib–Vb is investigated. Contact angles of wetting for nontransition metals surpass 90°. Wetting refractory borides with liquid silicon is accompanied by solid solution formation. Aluminum wets borides at temperatures of 1300 to 1400°C. In the systems MeB_2–Al, solid solutions are formed. The character of interaction is discussed from the viewpoint of the electronic structure of the contacting phase. (auth)

15861 EQUILIBRIA IN THE URANIUM–PLUTONIUM–NITROGEN TERNARY SYSTEM: AN ASSESSMENT. Potter, P. E. (EURATOM, Karlsruhe, Ger.). J. Nucl. Mater.; 47: No. 1, 7-16(May 1973).

Some assessments of possible equilibria for the ternary system uranium–plutonium–nitrogen were made and from these equilibria the pressures of the gas phase species Pu, U, and N_2 for the system were calculated. The nature of the vaporization behavior of alloys of the system is also predicted. (7 figures, 20 references) (auth)

15862 MEASUREMENTS OF THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE AT 670 TO 1270 K. Goldsmith, L. A.; Douglas, J. A. M. (United Kingdom Atomic Energy Authority, Seascale, Eng.). J. Nucl. Mater.; 47: No. 1, 31-42(May 1973).

Thermal conductivity measurements were made on porous stoichiometric and hyperstoichiometric uranium dioxide in the temperature range 670 to 1270°K using the laser-flash method. The pore volume fraction varied between 0.014 and 0.096 and the O/U ratios between 2.00 and 2.11. The variation of thermal conductivity (k) with pore volume fraction (P) at O/U ratios of 2.00 and 2.015 followed an equation of the form $k = k_0(1 - \beta P)$, where k_0 is the thermal conductivity of fully dense material, at all temperatures in the range covered. The value of β was independent of the temperature in both the stoichiometric and hyperstoichiometric material but had different values, 2.8 and 1.5 respectively, in the two materials. No explanation can at present be offered for this difference. The individual effects of three kinds of phonon scattering centers, viz. other phonons, impurities in the lattice and excess oxygen ions, were measured. The average phonon scattering cross section for excess oxygen ions was evaluated as 6.3×10^{-19} m^2. The thermal resistivity (R) of material having 96% of the maximum theoretical density, was shown to conform to an equation of the type $R = A + BT$, where both A and B are parameters which depend on the O/U ratio, and T is the absolute temperature. On the basis of the observations, it is suggested that the thermal conductivity of uranium dioxide might well become independent of both temperature and O/U ratio at temperatures above about 850°K and at O/U ratios in excess of about 2.13. (7 figures, 4 tables, 23 references) (auth)

15863 SURFACE AND INTERFACIAL PROPERTIES OF STOICHIOMETRIC URANIUM DIOXIDE. Hodkin, E. N.; Nicholas, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 47: No. 1, 23-30(May 1973).

Surface and grain-boundary energies and the surface diffusion coefficients of stoichiometric UO_2 were measured at temperatures of 1400 to 1700°C, using the multiphase equilibration technique. The surface energies decreased from 0.34 Jm^{-2} at 1400°C to 0.16 Jm^{-2} at 1700°C and, therefore, are lower than previously published estimates. However, most of these earlier estimates, which refer to lower temperatures, are consistent with the new data if the temperature dependence of the surface energy is assumed to be $\sim 4 \times 10^{-4}$ J/m^2 · °C. In contrast, the new grain-boundary energy/surface energy ratios are similar to other published estimates. The surface diffusion coefficients, derived from measurements of grain-boundary groove widths, are in good agreement with values deduced from tracer experiments but are several times greater than other published values obtained from mass transport kinetics. This discrepancy can be removed and all the published data unified if the values obtained from mass transport experiments are recalculated using the new surface energy values. (5 figures, 5 tables, 23 references) (auth)

15864 FISSION-GAS RELEASE IN CERAMIC FUELS DURING REACTOR OPERATION CYCLES. Mueller, E. M. J. Nucl. Mater.; 47: No. 1, 43-50(May 1973). (In German).

Gas release kinetics were calculated in terms of a bubble migration model; different release mechanisms are assumed to operate in various temperature ranges. It is assumed that fission gas is taken up by a bubble immediately after its formation and that the bubble becomes freed after passing the distance between the point of formation and a grain boundary (or, in the model, a zone boundary). The amount of gas released can be obtained by summing over all gas bubbles which can reach the grain boundary in the course of a specified time interval. In the operation of reactor cycles, one can use the assumption that the gas components from the different cycles do not mutually influence each other in respect of gas release; on the basis of this the total gas release can be calculated. The distribution of gas bubbles is calculated, so that for each cycle the position of the bubbles is known; this can then be used for the next cycle as the starting point for those gas bubbles which have not been released in the preceding cycle. If for each cycle start one represents the as yet unreleased gas in terms of a homogeneous gas distribution, this approximation offers computational simplifications but underestimates the gas release for low-temperature irradiation. (auth)

15865 MORPHOLOGY AND GROWTH RATE OF INTERLINKED POROSITY IN IRRADIATED UO_2. Beere, W.; Reynolds, G. L. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 47: No. 1, 51-57(May 1973).

A quantitative assessment is made of the morphology of penetrating gas phases formed along grain edges. The free energy of the configurations is calculated and the critical conditions found for instability and extensive interlinkage. The technique is applied directly to swelling in irradiated UO_2. The model developed predicts significant gas release after an incubation period and that subsequent release is by repeated venting of the interlinked porosity. Estimates are made of the characteristic times between venting. (6 figures). (auth)

15866 GRAPHITIZATION OF FREE CARBON PRECIPITATING DUE TO THE REACTION OF UC WITH N_2. Nomura, T.; Katsura, M.; Sano, T. (Osaka Univ.). J. Nucl. Mater.; 47: No. 1, 58-64(May 1973).

The degree of graphitization of the carbon precipitating due to the reaction of UC with nitrogen gas was studied as a function of temperature and nitrogen pressure. The degrees of graphitization were investigated in terms of the reflection angle $2\theta_B$, half-width B_M, and crystallite size t, which were determined from the (002) peaks of x-ray diffractometer patterns for these carbons. Result shows that the degree of graphitization increases with increasing temperature and with decreasing nitrogen pressure. The dependence of graphitization on nitrogen pressure can be explained well by a thermodynamical analysis of the reaction of UC with nitrogen gas. (auth)

15867 TERNARY COMPOUND $PuWC_{1.75}$. Ugajin, M.; Abe, J. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 47: No. 1, 117-120(May 1973).

Three $PuWC_{1.75}$ samples were examined by x-ray diffraction and microscopy. The pattern consists mainly of $UWC_{1.75}$-type monoclinic reflections with the W(110) reflection, and the d-spacings and relative intensities are tabulated. The lattice parameters are: $a_0 = 5.616 \pm 0.006$ Å, $b_0 = 3.252 \pm 0.004$ Å, $c_0 = 11.609 \pm 0.011$ Å, and $\beta = 109.83 \pm 0.07°$. An amended phase diagram of the system Pu–W–C is given. (DLC)

15868 OXYGEN REDISTRIBUTION IN $(U,Pu)O_{2-x}$. Olander, D. R. (Univ. of California, Berkeley). J. Nucl. Mater.; 47: No. 1, 113-116(May 1973).

In hypostoichiometric mixed oxides, at low fuel temperatures and in the absence of fission products, the O/M ratio profile is established by flow of gaseous H_2O or CO_2 balanced by solid-state O_2 diffusion. Profile calculations for closed axial thermal gradient geometry were performed for hot- and cold-end temperatures of 2000 and 1000°K for H_2O/H_2 mixtures (average O/M ratio = 1.96) and for CO_2/CO mixtures (average O/M ratio = 1.98). Results for H_2O/H_2 mixtures are in agreement with E. A. Aitken (J. Nucl. Mater., 30: 62(1969). The effects of free carbon and crack size on results for CO_2/CO mixtures are discussed. (DLC)

15869 BRITTLE FRACTURE OF OXIDE NUCLEAR FUEL. Roberts, J. T. A. (Argonne National Lab., IL). J. Nucl. Mater.; 47: No. 1, 125-128(May 1973).

Previous experiments were extended to higher strain rates close to 100 hr^{-1} for UO_2–20 wt % PuO_2 over the temperature range 0 to 1900°C. Results show that the effect of strain rate on brittle strength is either very small or negligible; the curve is described by $\sigma_F(MN/m^2) = 43.5 + 0.058\ T\ (°C)$. Comparison with UO_2 data shows that the strengthening effect of temperature is greater for the mixed oxide. Some conclusions are made regarding brittle fracture in oxide nuclear fuels. (DLC)

15870 FORMATION OF COMPOUNDS IN SYSTEMS OF TITANIUM AND ZIRCONIUM NITRIDE ALLOYS WITH HYDROGEN. Samsonov, G. V.; Antonova, M. M. J. Appl. Chem. USSR (Engl. Transl.); 46: No. 1, 11-15(Jan 1973).

Translated from Zh. Prikl. Khim.; 46: No. 1, 13-17(Jan 1973).

Study of the sorption capacity of titanium and zirconium nitride alloys for hydrogen in the temperature range from 25 to 1000°C under 1 atm hydrogen pressure showed that sorption of hydrogen by the cubic nitride phase in its homogeneity region reaches an amount corresponding to the nitrogen deficiency of the nitride without changes in the lattice of the original nitride during sorption. It was concluded that hydrogen occupies nitrogen-free octahedral positions in the nitride lattice. Sorption of hydrogen by two-phase nitride alloys proceeds with formation of a new hexagonal ternary phase. On the basis of an analysis of the dependence of the amount of hydrogen absorbed on the original composition, certain conclusions were drawn regarding the position of the lower boundaries of the homogeneity regions of titanium nitrides, and this position was compared with literature data. (auth)

15871 STUDY OF COORDINATION OF ALUMINUM IN SLAG GLASSES OF THE SYSTEM $CaO-Al_2O_3-SiO_2$ WITH THE AID OF ELECTRON SPIN RESONANCE AND HYDRATION OF THESE GLASSES. Royak, S. M.; Shkol'nik, Ya. Sh.; Orlov, V. V.; Orlova, L. A. J. Appl. Chem. USSR (Engl. Transl.); 46: No. 1, 16-19(Jan 1973).

Translated from Zh. Prikl. Khim.; 46: No. 1, 18-22(Jan 1973).

The methods of ESR and ir spectroscopy were used jointly for establishing the relationships between the composition of the slag glass specimens and variations of the distribution of aluminum between states of tetrahedral and octahedral coordination with oxygen. The test specimens did not contain natural paramagnetic impurities; therefore, they were subjected to gamma irradiation at 77°K. (DLC)

15872 ELECTRICAL CONDUCTIVITY OF URANIUM β-DIOXIDE MODIFIED BY ADDITIONS OF MgO, SrO, AND Nb_2O_5. Vlasov, V. G.; Pis'menko, V. T.; Ulyashev, S. P.; Shalaginov, V. N.; Beketov, A. R. J. Appl. Chem. USSR (Engl. Transl.); 46: No. 1, 34-37(Jan 1973).

Translated from Zh. Prikl. Khim.; 46: No. 1, 36-40(Jan 1973).

The conductivities of pure U_4O_9 and U_4O_9 containing 0 to 10.0% MgO or SrO, or 0 to 7.0% Nb_2O_5, were measured over the temperature range 300 to 800°K. Variation of conductivity from air, vacuum, and heat treatment were due to localization of conduction electrons near adsorbed oxygen. The temperature dependence of the conductivity shows three regions: low-temperature linear extrinsic conduction, intrinsic conduction, and high-temperature total conduction. Additions of MgO, SrO, or Nb_2O_5 changes not only the conductivity but also the transitions between the regions. Activation energies are tabulated for the regions of extrinsic, intrinsic, and ionic conduction in different compositions. The activation energies for intrinsic and ionic conduction vary with composition, while that for extrinsic conduction remains constant. (DLC)

15873 HIGH TEMPERATURE OXIDATION OF UO_2. Part I. Effect of Experimental Variables. Dharwadkar, S. R.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 10: No. 12, 1179-1181(Dec 1972).

The influence of compaction, exposed area, and the initial composition of the oxide on the oxidation of UO_2 at 1000°C and 40 μ pO_2 was studied employing thermogravimetry and quenching techniques. These parameters are found to have a profound influence on the shape of the kinetic curves. The results were interpreted on the basis of the sintering behavior of the product (U_3O_8) formed at this temperature. (auth)

15874 PROCESS FOR PREPARATION OF COMPOSITE MATERIALS STARTING WITH A SOLUTION OF METAL-CLAD PARTICLES OF FISSILE OR FERTILE MATERIAL FOR NUCLEAR REACTORS. Gyarmati, E.; Nickel, H. (to Kernforschungsanlage Juelich GmbH). German Patent 1,960,531. 16 Jun 1971. Filed date 3 Dec 1969. (In German).

The particles are compressed in a vacuum of 10^{-3} to 10^{-5} torr at a temperature between 800 and 2000°C under high pressure. (tr-auth)

15875 PROCESS FOR FABRICATION OF CERAMIC FUEL SUBSTANCES. Voelcker, H.; Klusmann, A. (to Steinkohlen Elektrizitaet AG). German Patent 1,955,581. 27 May 1971. Filed date 5 Nov 1969. (In German).

A process is described for the fabrication of ceramic fuel substances for reactor fuel elements. The fuel particles are placed in layers with graphite and compressed in molded pieces. They are then calcined. The fuel particles are made up of an envelope consisting of a mixture of graphite powder and a synthetic resin binder that is calcined. (TSS)

15876 MANUFACTURE OF POROUS ARTICLES. Burnett, R. C.; Chantot, H. J. P. (to United Kingdom Atomic Energy Authority). British Patent 1,309,395. 7 Mar 1973. Filed date 27 Feb 1970. 4p.

A process is described for manufacturing porous microspheres of UO_2 as a step in the manufacture of nuclear fuel, but which is also applicable to other oxides that, e.g., may be useful as catalysts or nuclear poisons. The oxides employed are those of metals exhibiting multivalency. The starting material is a higher oxide, which is sintered without lowering the oxygen/metal ratio; the sintered oxide is then heated in an atmosphere in which O is continuously removed to produce the lower oxide, the O removed from the article providing pores therein. The thermal decomposition process is preferably carried out under vacuum. Certain process limitations are mentioned. The O which leaves the sintered oxide does so by diffusion. This is also the case for a high densified matrix, where release occurs with more difficulty, and difficulties arise if a deep bed of small thin articles is temperature decomposed. Details are given of application of the process to uranium oxides. (UK)

15877 THERMAL PROPERTIES OF METALLIC HEXABORIDES. Dutchak, Ya. I.; Fedyshin, Ya. I.; Paderno, Yu. B. (Lvov State Univ.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 12, 1877-1880(Dec 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 12, 2134-2137(Dec 1972).

High-temperature x-ray-diffraction analysis was used in an investigation of the hexaborides CaB_6, YB_6, LaB_6, PrB_6, NdB_6, YbB_6, ThB_6, at 272 to 972°K. The temperature dependences of the lattice constant a(T), the true coefficient of thermal expansion $\alpha = \alpha_0 + \alpha_1 \cdot t$, and the contributions made to it by α_0 and α_1 (as percentages of α) are given. The temperature changes of the logarithm of the relative intensity ln (I/I_0) (where I_0 and I are the integral intensities at room temperature and T, respectively) were calculated. (auth)

15878 SOLID-PHASE REACTIONS OF MOLYBDENUM TRIOXIDE WITH LEAD, CADMIUM, AND ZINC OXIDES. Zobnina, A. N.; Kopeikin, S. I.; Kislyakov, I. P. (Moscow Inst. of Fine Chemical Tech.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 12, 1892-1895(Dec 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 12, 2149-2152(Dec 1972).

Lead, cadmium, and zinc oxides react rapidly with molybdenum trioxide at 200°C. The reactions are most intense at 450 to 550°C for all three molybdates. Formation of neutral molybdates begins at lower temperatures, and formation of basic molybdates takes place at higher temperatures with direct participation of the neutral molybdates. The presence of liquid eutectic phases and polymorphic transitions markedly increases the reaction velocity. From the results of thermographic and kinetic investigations, the formation mechanism of lead, cadmium, and zinc molybdates was determined and the velocity constants and activation energies of these reactions were calculated. (auth)

15879 EFFECT OF ADDITIVES ON THE KINETICS OF THE SOLID PHASE REACTION BETWEEN La_2O_3 AND Fe_2O_3. Kniga,

M. V.; Sirotkina, A. G. (Belorussian State Univ., Minsk). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 12, 1908-1911(Dec 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 12, 2168-2171(Dec 1972).

A study was made of the effect of admixtures of Li_2O, Cr_2O_3, and TiO_2 on the kinetics of the solid-phase reaction between La_2O_3 and Fe_2O_3 in the range 900 to 1200°C. Incorporation of 1 and 2 mole % Cr_2O_3 into ferric oxide increases the rate of the reaction with La_2O_3, but incorporation of Cr_2O_3 into lanthanum oxide, and of Li_2O and Ti_2O into ferric oxide, retards the reaction. The effect of these additives decreases with increasing temperature. Incorporation of 2 mole % Cr_2O_3 into ferric oxide reduces the activation energy by 11 kcal/mole. Incorporation of these additives increases the conductivity of the synthesized products and reduces their relative density. (auth)

15880 STRENGTH OF GRAPHITES IN A PLANE STRESSED CONDITION. Fridman, A. M.; Barabanov, V. N.; Anufriev, Yu. P.; Strokov, V. I. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1434-1436(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1137-1140(Sep 1972).

Equipment was developed for determining the strength properties in a plane stressed condition for graphitized carbons. The apparatus consists of a loading compartment and a system for filling the operating cavities with oil and removing it after tests. The experiment is described and tests were made on specimens of two types of contructional graphite. Specimens were tested (five or six per control point) with an external dimension (diameter $44^{-0.1}$) that was kept constant, but the thickness was varied from 2 to 6 mm for a type VPP medium-grain graphite, and from 1.5 to 3 mm for a type MPG-3 fine-grain graphite. The results of the strength change during elongation and compression in relation to wall thickness of specimen are shown. (MCW)

15881 EFFECT OF ZIRCONIUM ADDITIONS ON THE SURFACE TENSION OF Cu–Al ALLOYS AND THE INTERPHASE TENSION WITH URANIUM DIOXIDE. Pastushkov, V. G.; Novoselov, G. P.; Borisov, G. B. At. Energ. (USSR); 34: No. 5, 345-348(May 1973). (In Russian).

The contact angles of wetting of uranium dioxide by melted CuAl–(0 to 20%) Zr alloys were measured by the sessile-drop method in the temperature interval 1200 to 1500°C. The values of surface tension, adhesive force, and interphase tension in this system were determined. It is shown that uranium dioxide is neither wetted nor interacts with liquid Cu–Al–Zr alloys in an inert atmosphere up to 1500°C. (5 figures, 13 references, 1 table) (auth)

15882 CRYSTALLOGRAPHIC ASPECTS OF THE TETRAGONAL ⇌ MONOCLINIC PHASE TRANSFORMATION IN ZIRCONIA. Bansal, G. K. Cleveland; Case Western Reserve Univ. (1973). 143p. University Microfilms Order No. 73-16,111.

Thesis (Ph. D.).

The orientation relationships between the high- and low-temperature phases were determined using high-temperature (~1000°C) Buerger x-ray precession photographs. Two different orientation-relationships were observed. The transformation, below M_s, is thought to occur martensitically according to the relations: $(100)_m \parallel (100)_{fct}$ and $[001]_m \parallel [001]_{fct}$. Several different morphologies, each having different orientations, of the low-temperature phase were observed. The habit plane(s) indices of plate-like martensite products were determined by two-surface analysis. Four different habit planes are observed which are close to {100}, {671}, {111}, and {702} planes of the face-centered tetragonal cell. Lathes are occasionally present along the $[100]_m$ monoclinic direction. The crystallographic theory (W–L–R) of martensitic transformations was successfully applied to this system. In addition to confirming the existence of the {100} and {671} habit planes, the theory predicted that both the habit plane(s) and orientation relationships(s) are irrational. The different habit planes are believed to result from a single Bain correspondence combined with different lattice-invariant deformation modes. The possibility of a premartensitic behavior, prior to the onset of the martensitic transformation, is suggested. This gives rise to diffuse electron scattering from a highly dislocated and strained plate-free region. These regions are believed to originate from a different orientation relationship: $(100)_m \parallel (100)_{fct}[010]_m \parallel [001]_{fct}$. The observed orientation-relationships between the two lattices can be predicted from the atomic movements occurring during the transformation and are consistent with the experimental observations. (Diss. Abstr. Int., B)

15883 OXYGEN PRESSURE OVER HYPOSTOICHIOMETRIC URANIUM DIOXIDE. Winslow, G. H. (Argonne National Lab., IL). High Temp. Sci.; 5: No. 3, 176-191(Jun 1973).

A statistical mechanically oriented description of the oxygen potential–composition relation was found that fits the observations by Tetenbaum and Hunt on urania and connects these to the lower phase boundary without apparent systematic deviation. The equations are based on the vacancy model of hypostoichiometry and include vacancy pair interactions. It was necessary to separate the isotherms into two groups to provide an accurate fit to the observations. A single model provides such a fit to the four high-temperature isotherms throughout the composition range. The equations that fit the three low-temperature isotherms are useful for comparison with other work, but they imply a shift in configurational entropy, as O/U decreases, which is contrary to expectation. The observations made by Tetenbaum and Hunt, wherever O/U can be described solely by the vacancy concentration, are verified by other work, but their oxygen pressures at O/U near to and greater than 2.000 appear to be too low. (auth)

15884 APPLICATION OF RADIOACTIVE TRACERS FOR CORROSION STUDIES. Akerman, K. Chem.-Anlagen Verfahren; No. 5, 61-64(1972). (In German).

A brief survey is given on the application of radiotracers and autoradiography in the investigation of the following processes: 1) anion adsorption; 2) surface heterogeneity; 3) inhibitor effect; 4) Fe and Cl ion residues on printed circuits after pickling; 5) corrosion and erosion of ceramic liners. (GE)

15885 RADIATSIONNAYA I KORROZIONNAYA STOIKOST' ELEKTROKERAMIKI. (Radiation and Corrosion Stability of Electroceramics). Kostyukov, N. S.; Kharitonov, F. Ya.; Antonova, N. P. Moscow; Atomizdat (1973). 224p.

The applications of ceramic materials in the field of atomic power, radioelectronics and similar fields are discussed. Various factors in the corrosion of ceramic materials and testing methods are examined for a number of liquids: water, steam, mineral acids, alkalis, nonelectrolytes, molten salts and alkali metals. The last quarter of the monograph is concerned with the radiation stability of ceramic materials, their property changes after exposure to ionizing radiations: electrical insulation, density, temperature coefficient of expansion, electrophysical and mechanical properties. Components of the materials discussed include Al_2O_3, ZrO_2, MgO, BeO, TiO_2, MnO_2, Cr_2O_3, and SiO_2. 350 references. (KSW)

15886 REACTION OF RHENIUM WITH ZIRCONIUM CARBIDE AT HIGH TEMPERATURES. Vil'k, Yu. N.; Danisina, I. N.; Omel'chenko, Yu. A. (Leningrad State Scientific Research and Design Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 130-132 (Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 145-148(Jan 1973).

The phase equilibria at 2000 to 2400°C were investigated by isothermal annealing, microscopy, x-ray phase, and chemical analysis. The Zr–Re–C phase diagram at 2000°C was constructed, and composition changes and phase field distributions at 2200 and 2400°C were determined. Lattice constants of solid solutions of Re in ZrC are tabulated. The solubility of Re in ZrC at 2000°C is <0.7 at. %. Reaction of ZrC–Re resulted in decarbonization. 67.5 at % Re was the eutectic point in the ZrC–Re cross section. The ternary field is solid solution (ss) of Re in ZrC, ss of Zr and C in Re, and Zr_5Re_{24}, with the eutectic point at 2400°C and ~13.5 at. % Re. (DLC)

15887 ELECTRON SPIN RESONANCE OF Gd^{3+} IONS IN LANTHANUM HYDRIDE MATRICES. Drulis, H.; Stalinski, B. (Inst. of Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 21: No. 1, 65-70(1973).

Electron spin resonance g-shifts and linewidths were determined in the temperature range 77 to 300°K and 120 to 470°K, respectively for Gd^{3+} ions in the nonmagnetic lanthanum hydride hosts $La(Gd)H_x$ with $1.91 < x < 2.90$. The observed g values indicate the covalent mixing to be the dominating mechanism of exchange interaction. It was found that the temperature dependence of the linewidth of the samples behaves differently depending whether $x < x_c$ or $x \geq x_c$. For $x < 2.29$, the linewidth is proportional to the temperature, being in good agreement with the Korringa relationship. For samples with $x \geq 2.29$, the linewidth changes with increasing temperature in an unusual way, probably connected with the phase transition in lanthanum hydride. (auth)

15888 ELLIPSOMETRIC ANALYSIS OF REFRACTIVE INDEX PROFILES PRODUCED BY ION IMPLANTATION IN SILICA GLASS. Bayly, A. R.; Townsend, P. D. (Sussex Univ., Brighton, Eng.). J. Phys., D (London); 6: No. 9, 1115-1128(11 Jun 1973).

An experimental method for measuring directly refractive index profiles, produced by ion implantation, is described. This uses surface-stripping techniques to enable a series of ellipsometric measurements to be made through the altered surface layer. The data are translated into a complex refractive index profile using a FORTRAN IV computer program. Sensitivities and error limits are discussed and results obtained for 300-keV Ar implant in

vitreous silica are presented to demonstrate the capabilities of the technique. The technique is compared with other published work, where either profiling techniques or homogeneous layer approximations have been used, to show that the method described has advantages in determining the relative contributions of radiation damage and implanted species to the refractive index modification. (auth)

15889 DEFORMATION AND RECRYSTALLIZATION OF REFRACTORY COMPOUNDS. Samsonov, G. V.; Kushtalova, I. P. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 41-42(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 46-47(Jan 1973).

Grain growth during accretive recrystallization of refractory compounds was investigated. Kinetic parameters were determined for the carbides of Ti, Nb, Mo, and W, the borides of Ti and Zr, and $MoSi_2$. (auth)

15890 CHANGE IN CARBON DISTRIBUTION IN NONSTOICHIOMETRIC ZIRCONIUM CARBIDE DURING CREEP TESTS. Dement'ev, L. N.; Zubarev, P. V.; Ivanov, L. I.; Nikitina, M. V. (Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 43-45(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 48-50(Jan 1973).

It is shown that creep tests in vacuum are accompanied by decarbonization of the surface layers of zirconium carbide specimens. No change is observed in the chemical composition of the specimens when the tests are performed in an inert atmosphere. During bending tests, the chemical composition of zirconium carbide in the deformed zones of the specimen changes owing to ascensional diffusion. The carbon content of the elongated sectors is higher than in the compressed sectors. (auth)

15891 USE OF X-RAY ANALYSIS TO INVESTIGATE THE REACTIONS OF EUROPIUM OXIDE WITH VANADIUM AND NIOBIUM PENTOXIDES. Kiparisov, S. S.; Belyaev, R. A.; Bondarenko, V. V.; Vyskubov, V. P. (Moscow Inst. of Steel and Alloys). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 61-63(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 68-71(Jan 1973).

Reactions in the systems $Eu_2O_3-V_2O_5$ and $Eu_2O_3-Nb_2O_5$ were investigated in the range 500-1500°C. It was found that the system $Eu_2O_3-V_2O_5$ contains two compounds $Eu_2O_3 \cdot V_2O_5$ and $3Eu_2O_3 \cdot V_2O_5$, and the system $Eu_2O_3-Nb_2O_5$ four compounds: $3Eu_2O_3 \cdot Nb_2O_5$, $Eu_2O_3 \cdot Nb_2O_5$, $Eu_2O_3 \cdot 3Nb_2O_5$, and $Eu_2O_3 \cdot 5Nb_2O_5$. Lattice constants of the compounds were determined. (auth)

15892 CRYSTALLIZATION OF ZIRCONIUM, HAFNIUM, AND TITANIUM MOLYBDATES FROM A SOLUTION IN AN Li_2O-MoO_3 MELT, AND SOME OF THEIR PROPERTIES. Klevtsov, P. V.; Zolotova, E. S. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 70-72(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 79-82(Jan 1973).

Using spontaneous crystallization with decreasing temperature of solutions in melts $RO_2-MoO_3-Li_2MoO_4$ ($Li_2Mo_2O_7$), normal molybdates $R(MoO_4)_2$ were synthesized for R = Zr and Hf and double molybdates $Li_2R(MoO_4)_3$ for R = Zr, Hf, and Ti. The formation conditions of molybdates were investigated. Double molybdates $Li_3R(MoO_4)_3$ crystallize in the orthorhombic system with an $Li_3Fe(MoO_4)_3$ structure. They do not exhibit polymorphic transitions. All these molybdates decompose when heated. (auth)

15893 Lα EMISSION BANDS OF VANADIUM IN HYDRIDES AND CARBOHYDRIDES. Brytov, I. A.; Kurmaev, E. Z.; Konashenok, K. I.; Antonova, M. M. Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 122-124(Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 137-139(Jan 1973).

X-ray emission spectra were studied in the cubic (10 at. % H) and tetragonal (35 at. % H) phases of V hydride and $VC_{0.72}H_{0.11}$ and $VC_{0.85}H_{0.23}$. The Lα bands of the V hydrides are similar to the band of pure V, whereas the K spectrum of the dihydride contains an additional low-energy band, indicating that the 1s states are localized in the low-energy region and that H may be in the form of negative ions. Both the K and L spectra of the carbohydrides are similar to those of $VC_{0.88}$, indicating similar electronic structures. (DLC)

15894 METALLOTERMICHESKIYE METODY POLUCHENIYA SOYEDINENIY I SPLAVOV. (Metallothermic Methods for Preparing Compounds and Alloys). Kornilov, A. A. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka (1972). 80p.

The optimal conditions for preparation and the physico-chemical characteristics of the compounds obtained were determined; in individual cases, attempts to elucidate the mechanism and kinetics of the reduction process are given. Thirteen articles are presented on the aluminothermal preparation of AlB_{12} from various boron-containing minerals; compounds and alloys in the silicon–boron system, SiB_4 in particular; magnesiothermal preparation and structure of cobalt–magnesium and nickel–magnesium alloys; germanio-thermal reduction of molybdenum anhydride in vacuum to obtain $MoGe_2$; the preparation of aluminides of rare earth metals having the composition $MeAl_4$ by the aluminothermal reduction of oxides; the alumino-thermal reduction of cobalt and nickel chlorides and the tensometric study in the cobalt chloride-nickel chloride and aluminum–aluminide systems; preparation of ternary alloys and aluminides from the molybdenum–nickel–aluminum system by the aluminothermal reduction of oxides. Studies of the physical properties are presented for the germanium compounds of some of the transition metals relative to the nature of the intermetallic compounds in the tungsten–germanium system. (auth)

15895 EXPERIMENTAL INVESTIGATION OF THERMAL EXPANSION IN COMPOSITE FIBROUS MATERIALS. Salibekov, S. E.; Portnoi, K. I.; Chubarov, V. M. High Temp. (USSR) (Engl. Transl.); 10: No. 4, 702-706(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 4, 783-787(1972).

The laws governing thermal expansion of composite fibrous materials are investigated. It is shown that the calculated results are in satisfactory agreement with experimental data only for materials whose components have properties (α, E, ν) which do not differ significantly. Thermal expansion of composites of the system metal–nonmetal, and copper–tungsten is determined to a significant degree by the elastic–plastic behavior of the matrix under the action of residual and thermal stresses. (auth)

15896 PRECIPITATION PHENOMENA OBSERVED IN TANTALUM SURFACE CARBURIZED IN THE VAPOR PHASE. Dubois, J.; Mai, C.; Riviere, R. (Institut National des Sciences Appliques, Villeurbanne, France). Mem. Sci. Rev. Met.; 70: No. 4, 327-334 (Apr 1973). (In French).

An attempt was made to carburize the surface of tantalum samples at high temperatures by the transfer of carbon in the vapor phase. Precipitation phenomena were observed in the surface diffusion films. Analyses were affected using Knoop microhardness measurements, metallography, and x-ray crystallography. (FR)

15897 VARIATION OF THE FREE ENTHALPY OF FORMATION OF CERTAIN CARBIDES WITH TEMPERATURE. Ancey-Moret, M. F. (Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France); Deniel, M. Y. Mem. Sci. Rev. Met.; 70: No. 4, 301-307(Apr 1973). (In French)

Curves representing the variation of the free enthalpy of formation of certain stoichiometric carbides (those of Al, B, Be, F, Ca, Ce, Co, Cr, Fe, Mn, Mg, Na, Ni, Si, and W) are presented. The data used to establish these curves were obtained from critical examinations of experimentally measured thermochemical parameters. The way in which the free enthalpy of formation was calculated in terms of the temperature is given, together with the way in which the specific heats are represented by computer. A rapid approximate graphical solution method for some particular metallurgical problems is exposed. (FR)

15898 FRICTION IN METALLIC MONOCRYSTALS: Cu, Al, Be, Co, Zn, and Cd. Barquins, M. (CNRS, Meudon, France). Metaux (Corros.-Ind.); 48: No. 571, 86-116(Mar 1973). (In French).

Friction results in the deformation of solids in contact and their adhesion. The plastic deformation of metallic monocrystals was studied using a hard nonadhesive polished sapphire ball. The size, relief, and structure of the surface damage caused was determined in the case of fcc crystals (Cu and Al), and hexagonal crystals (Be, Co, Zn, and Cd). (FR)

15899 MODERN OXIDE MATERIALS. Preparation, Properties, and Device Applications. Cockayne, B.; Jones, D. W. (Eds.). New York; Academic Press, Inc. (1972). 320p. $12.50.

Information in the book is presented in 12 lectures. A separate abstract was prepared for each of three lectures; the remaining nine were not considered in the scope of NSA. (JRD)

For abstracts of individual chapters see: 15900–15902.

15900 OXIDES FOR REFRACTORY AND ENGINEERING APPLICATIONS. Matkin, D. I. (Atomic Energy Research Establishment, Harwell, Eng.). pp 235-257 of Modern Oxides Materials. Preparation, Properties, and Device Applications. Cockayne, B. (ed.). New York; Academic Press, Inc. (1972).

Traditional oxide ceramics were based on clays and silicates, while modern technical oxide ceramics are generally pure single oxides, e.g., Al_2O_3, MgO, ZrO_2, BeO, or pure mixed oxides, e.g., spinel ($MgO \cdot Al_2O_3$), mullite ($3Al_2O_3 \cdot 2SiO_2$), and zircon ($ZrO_2 \cdot$

SiO_2). The properties of such polycrystalline oxides are discussed along with the influence of microstructure on these properties, and the influence of the chosen fabrication process on the microstructure. Refractory and engineering applications of oxide ceramics are also reviewed. (6 figures, 13 references) (JRD)

15901 OXIDES IN COMPOSITES. Harris, B. (Univ. of Sussex, Brighton, Eng.). pp 258-287 of Modern Oxides Materials. Preparation, Properties, and Device Applications. Cockayne, B. (ed.). New York; Academic Press, Inc. (1972).

Information and discussions are presented related mostly to composites comprising metals and plastics reinforced with Al_2O_3 or SiO_2 in the form of particles, crystals, or fibers. Sections are included on strong oxide solids, preparation of high-strength oxides, brittle solids, particulate composites, and fibrous composites.. (7 figures, 14 references) (JRD)

15902 CHEMICAL PREPARATION AND ANALYSIS OF OXIDES. Bradley, N. J.; Cooper, B. S.; Hobbs, D. J. (Johnson Matthey Chemicals Ltd., Royston, Eng.). pp 288-306 of Modern Oxides Materials. Preparation, Properties, and Device Applications. Cockayne, B. (ed.). New York; Academic Press, Inc. (1972).

Pure oxides are used in the preparation of lasers, electro-optic devices, ferrites and for numerous other applications. Examples are used to illustrate the wide scope of the demands of the electronics industry, and the necessary stringent restrictions this places on their production. Details of specific methods of manufacture are given together with more general purification procedures, and details of analytical techniques available for process control. (JRD)

15903 FRACTURE MECHANICS OF COMPOSITES. Corten, H. T. (Univ. of Illinois, Urbana). pp 675-769 of Fracture: an Advanced Treatise. Vol. VII. Liebowitz, H. (ed.). New York; Academic Press, Inc. (1972).

The concepts of linear-elastic fracture mechanics are introduced and their application to the interpretation of fracture behavior of composite materials is illustrated. Linear-elastic fracture mechanics is based on a description of the linear-elastic stress field around the tip of a crack. The equations for stresses close to a crack tip in a homogeneous, isotropic plane plate are developed. These equations lead directly to the definition of the stress-intensity factor K, a single-parameter characterization of the crack-tip stress field. The level of K corresponding to crack extension and fracture is a measure of the fracture toughness of a material. For fibrous composites, crack-tip stress field equations and the stress-intensity factors for a linear-elastic special orthotropic homogeneous material are introduced. Small-scale plastic behavior at the crack tip and its influence on the crack-tip stress field and stress-intensity factor K are discussed. Crack extension force G is defined and related to the stress-intensity factor K. Crack-tip stress fields for two-material members with cracks at and near the interface are presented. Fracture analysis for two particulate composite systems, a WC-reinforced cobalt alloy and a W-particle reinforced glass composite are reviewed. A parallel filament glass-epoxy composite is traced through a failure analysis, as well as experiments designed to investigate the applicability of fracture mechanics, using a special orthotropic homogeneous material model, to describe the observed crack extension behavior. The general features of crack extension behavior, specifically the observed relation between G and crack speed $\dot{a}$ are discussed and illustrated for epoxy-aluminum adhesive joints. The influence of moisture and sustained loads on the crack extension behavior of epoxy adhesive joints are reported. A discussion of the areas of fracture mechanics, both analytical and experimental, that require attention to develop improved composite materials and structural systems is included. (60 figures, 68 references) (auth)

15904 MICROSTRUCTURAL ASPECTS OF THE FRACTURE OF TWO-PHASE ALLOYS. Gurland, J. (Brown Univ., Providence); Parikh, N.M. pp 841-878 of Fracture: An Advanced Treatise. Vol. VII. Liebowitz, H. (ed.). New York; Academic Press, Inc. (1972).

The fracture of two-phase alloys consisting of hard and relatively brittle particles embedded in a soft and relatively ductile matrix is discussed. In dilute alloys, the particles act as inclusions which alter the homogeneity of the internal stress field, causing stress concentration and residual stresses. Crack initiation takes place at the particles but, generally, only after the onset of overall plastic deformation, as shown in detail by a quantitative study of the fracture of silicon particles in aluminum–silicon alloys. The presence of brittle particles reduces the ductility of metals, the extent depending mainly on the volume fraction of the particles. An attempt to relate analytically the elongation at rupture to the volume concentration of rigid particles is discussed. The fracture behavior of alloys with high concentrations of a hard phase is described on the basis of two cermet-type systems; one, a so-called heavy metal, W–Ni–Fe; the other, a cemented carbide, WC–Co. In both alloy systems, the fracture studies indicate that, as the hard particle content is increased, the fracture initiation site changes from matrix to particle or particle interface, and the fracture propagation path also changes from matrix to matrix and particles. The fracture strength first increases with particle concentration, but the change from a ductile to a brittle fracture mode eventually leads to lower fracture strengths at high particle concentrations. (33 figures, 28 references) (auth)

15905 PERFORMANCE OF MIXED-OXIDE FUEL ELEMENTS TO 11 AT.% BURNUP. Neimark, L. A.; Lambert, J. D. B.; Murphy, W. F.; Renfro, C. W. (Argonne National Lab., IL). Nucl. Technol.; 16: No. 1, 75-88(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Two stainless-steel-clad mixed-oxide fuel elements were examined after irradiation in EBR-II to a burnup of 11 at.%. The comparison of fuel of low oxygen-to-metal (O/M) ratio (1.94 to 1.97) with fuel of high O/M ratio (1.99 to 2.00) indicated significant differences in fuel and fission-product behavior. The lower oxidizing potential of the low O/M ratio fuel generated no attack of the Type 316L cladding. This appeared to be related to the lack of oxidation and migration of fission-product molybdenum to the cladding surface. Carbide precipitation in the cladding also appeared to be a factor in the type of attack that occurred. Cesium, however, was mobile in both fuels. The separation of the fuel and cladding at high burnup is thought to be related to the deposition of Cs–Mo–O at the interface. In the low O/M ratio fuel, in which the molybdenum did not migrate to the interface, the fuel and cladding remained in contact. The diametral change in the low O/M ratio element, however, was less than in the high O/M ratio element, 3.55% compared with 4.60%. This lower deformation is attributed to greater internal swelling accommodation by the more plastic low O/M ratio fuel. The axial migration of cesium in the low O/M ratio element resulted in an apparently nondetrimental reaction with the UO_2 blanket and insulator pellets. (11 figures) (auth)

15906 HIGH BURNUP MIXED-OXIDE FUEL IRRADIATION EXPERIMENTS. Coquerelle, M.; Gabolde, J.; Lesser, R.; Werner, P. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Nucl. Technol.; 16: No. 1, 110-119(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

A series of mixed-oxide irradiation experiments was performed in the Dounreay Fast Reactor. The main parameters varied were the O/M ratio of the fuel, radial fuel distribution, and fuel form. Three low burnup experiments with nine pins were terminated in 1969. Eight of the corresponding nine high-burnup pins were removed from the reactor subsequently, after several intermediate nondestructive examinations. One pin is further irradiated. Three of the eight pins failed. The Inconel-625 claddings of the sound pins did not change their OD at a total neutron dose of 7.3×10^{22} n/cm^2. The three pins of the DS-2 experiment, in which fuels with different O/M ratios have been irradiated to a burnup of 7.3 at.%, were examined destructively. A low initial O/M (1.94) led to a negligible attack of the cladding at a maximum temperature of 650°C, whereas fuel of stoichiometric composition corroded severely. No influence of the different O/M on the swelling was detected. The reduction of the O/M ratio to low values seems to increase the risk of central fuel melting. (10 figures). (auth)

15907 POROSITY AND ACTINIDE REDISTRIBUTION DURING IRRADIATION OF $(U,Pu)O_2$. Lackey, W. J.; Homan, F. J.; Olsen, A. R. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 1, 120-142(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Thermal-gradient-induced redistribution of porosity and fuel components during irradiation of $(U,Pu)O_2$ alters the fuel thermal conductivity, melting point, mechanical properties, and radial heat generation profile sufficiently to influence fast breeder reactor fuel pin performance. Analytical models, which should prove useful in design and analysis of such fuel pins, were developed for predicting radial porosity and Pu: (U + Pu) profiles. The interrelated porosity and actinide redistribution models are kinetic and based on the evaporation-condensation mechanism of material transport. The models were shown to yield predictions in accord with experimentally measured porosity and actinide profiles for an irradiated pin containing stoichiometric fuel. The volume-averaged porosity of the columnar grain region of irradiated pins was 5.9 and ≥3.8% after burnups of 0.7 and 4.2% FIMA, respec-

tively. The columnar grains are thus more porous than previously believed. (10 figures, 62 references) (auth)

15908 POSTIRRADIATION OBSERVATIONS OF MIXED OXIDES WITH INITIAL ADDITION OF FISSION-PRODUCT ELEMENTS. Conte, M.; Mouchnino, M.; Schmitz, F. K. (CEN, Fontenay-aux-Roses, France). Nucl. Technol.; 16: No. 1, 143-155(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

A mixed oxide ($U,Pu)O_2$ containing five elements (Mo, Ru, Ba, Zr, and Ce) representative of the fission product yield at 150,000 MWd/t underwent a short-term irradiation to obtain the characteristic microstructure changes and redistribution of additional elements. The most important post-irradiation observations on these oxides are: (1) the absence of the columnar structure in the samples containing molybdenum, (2) a plutonium enrichment in the center of some stoichiometric oxides, and (3) the presence of a metallic ingot at the upper end of the central void in one of the pins containing ruthenium. The thermal behavior was shown to be unfavorably affected by fabrication parameters such as low O/M, low density, and addition of soluble elements, whereas stoichiometric composition and possibly addition of molybdenum are favorable characteristics. The O/M ratio was found to be the most important parameter governing the migration of actinides and fission products. (4 tables, 6 figures) (auth)

15909 DEVELOPMENT OF CYGRO-F FOR FUEL ROD BEHAVIOR ANALYSIS. Harbourne, B. L.; Beck, M. S.; Foster, J. P.; Biancheria, A. (Westinghouse Electric Corp., Madison, PA). Nucl. Technol.; 16: No. 1, 156-170(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

An LMFBR fuel rod performance analysis system was developed using the CYGRO-F computer code. Uncertainties were resolved by normalizing the code against selected experimental results and making appropriate adjustments to the models. Result is an analytical system of models integrated into a central stress–strain analysis. Application of the system to independent experimental data gave satisfactory agreement between analysis and observation. Four highly significant models have emerged from this work. The analytical fuel swelling model simulates volume increase saturation and subsequent volume conservate growth which can result in center-hole growth independent of pore migration. The feasibility of a fundamental fuel swelling model has been demonstrated. This model describes the nucleation, growth, and migration of gas bubbles and produces mechanical effects similar to those in the analytical model. The cladding swelling model accounts for the effects of stress on swelling rate to reproduce the large volume changes observed in some fuel rod cladding. The results of this model are in qualitative agreement with fundamental analyses of the effect. Studies of startup and early life behavior resulted in a thermomechanical analysis system which describes in detail the complex interacting phenomena occurring under these transient conditions. (17 figures, 3 tables, 27 references) (auth)

15910 EXAMINATION OF F3A SERIES UNENCAPSULATED MIXED OXIDE FUEL PINS IRRADIATED IN EBR-II. McCarthy, W. H. (General Electric Co., San Jose, CA); Perry, K. J.; Hull, G. R.; Bennett, J. W. Nucl. Technol.; 16: No. 1, 171-186(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Sixteen unencapsulated mixed-oxide fuel pins were irradiated in EBR-II to ~5 at.% burnup at 16 kW/ft nominal peak linear power. The fuel fabrication parameters were varied within the ranges proposed for commercial liquid-metal fast breeder reactors (LMFBR) except that pin diameter was ~15% larger than usually specified. No cladding failures occurred. Pin growth was substantially greater in Type 304L stainless-steel-clad fuel pins than in Type 316 clad elements. Fission gas release to the internal void volume ranged from 73 to 97%. Experimental burnup values were 10 to 12% less than calculated values and varied across the subassembly in a manner that indicated a significant fission rate elevation from an adjacent extra-worth driver subassembly. Substantial attack was found in the cladding at its inside surface and the extent of this attack (up to 0.009-in. intergranular penetration at about 1150°F) correlated with temperature but not with any fuel fabrication parameter. The penetrating fission product material contained Cs, Mo, and Te. The unusually large amount of fuel/fission product/cladding reaction may be related to the high carbon content in the mixed oxides and/or to a short high-temperature operating period. (13 figures, 12 references) (auth)

15911 IRRADIATION-INDUCED DIMENSIONAL CHANGE IN BORONATED GRAPHITE. Stansfield, O. M. (Gulf General Atomic Co., San Diego, CA). Nucl. Technol.; 16: No. 1, 197-207 (Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Boronated graphites containing 22 to 43 wt % boron as B_4C and representing current warm-pressing or extrusion technology were irradiated at 650 ± 100°C to fast-neutron fluences up to 7×10^{21} n/cm^2 (E > 0.18 MeV). The irradiation caused an increase in thermal expansivity, a decrease in thermal conductivity, and an anisotropic dimensional change related to the preferred orientation of the graphite crystallites in the graphite matrix. Although irradiation-induced B_4C swelling has been reported, the dimensional change in boronated graphite is not significantly influenced by that effect. Dimensional change in boronated graphite is controlled by the fast-neutron and ^{10}B fission damage irradiation properties of the graphite–binder matrix. At a constant ^{10}B-isotope concentration, the irradiation-induced dimensional change of the boronated graphite increases with increasing ^{10}B-isotope enrichment of the boron in the B_4C addition. This effect, which may result from more severe ^{10}B fission fragment damage in the matrix surrounding ^{10}B-enriched B_4C, leads to distortion directly related to the ^{10}B burnup gradient. The use of natural boron in the fabrication of boronated graphite results in dimensional changes independent of the ^{10}B burnup gradient and correlated with fast-neutron fluence under HTGR service conditions. (9 figures) (auth)

15912 EMPIRICAL HELIUM RELEASE FUNCTION FROM THERMAL-REACTOR-IRRADIATED BORON CARBIDE. Russcher, G. E.; Pitner, A. L. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 208-215(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Thirty-five sets of thermal reactor data were analyzed to derive a best fit function to predict gas release from boron carbide as a function of temperature, irradiation exposure, and material density. An exposure variable to account for difference in self-shielding in various reactor spectra was developed. The data used in the analysis included temperatures from 550 to 1200°F, irradiation exposures from 10×10^{20} to 31×10^{20} captures/g, and material densities of 2.0 and 2.5 g/cm^3 (80 and 99% of the theoretical density). Within this range the function should predict gas release in all reactor spectra within the 20% estimated accuracy of the experimental data. Independent gas release data generated in fast and intermediate reactor spectra showed that the general form of the function is correct but that application to temperature conditions above the specified range may result in overestimates of gas release. (3 tables, 12 figures) (auth)

15913 PERFORMANCE MODELING OF NEUTRON ABSORBERS. Homan, F. J. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 1, 216-225(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

A computer code to predict the performance of fast reactor control rods was developed and used to analyze the integrated behavior of a proposed FTR-type control rod in Row 2 of EBR-II. In particular, the influence of the ^{10}B enrichment and solid reaction product swelling was considered. It is noted that control rod claddings are predicted to begin rapid plastic strain very shortly after the fabricated gap between the absorber pellets and the cladding has closed, due to high contact pressure which develops with continued pellet swelling. Models for helium gas bubble swelling and release are presented, which suggest minimum swelling from this source at about 1000°C. (12 figures, 25 references) (auth)

15914 IRRADIATION BEHAVIOR OF BORON CARBIDE. Copeland, G. L.; Donnelly, R. G.; Martin, W. R. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 1, 226-237(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Boron carbide is the prime candidate material for neutron absorbers in fast breeder reactors and the Fast Test Reactor. Important data required for design of control rods for these reactors concern swelling, gas release, and structural integrity of boron carbide under the expected operating conditions. Data for irradiations of boron carbide powders in a thermal reactor and powders and pellets in a fast reactor are presented and discussed in terms of expected performance in a fast reactor. The most important variable in determining irradiation behavior appears to be the mobility of the helium produced relative to the rate it is produced. The helium is not trapped in the lattice but precipitates. Denuded zones and absence of bubbles on grain boundaries suggest that helium diffuses rapidly along the grain boundaries. This is a major source of gas release. (14 figures) (auth)

15915 IRRADIATION EFFECTS IN BORON CARBIDE PELLETS IRRADIATED IN FAST NEUTRON SPECTRA. Basmajian, J. A.; Pitner, A. L.; Mahagin, D. E.; Ripfel, H. C. F.; Baker,

D. E. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 238-248(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Fast-neutron-spectra irradiations of boron carbide are being performed. Hardened spectra irradiations in ETR, material irradiations in EBR-II, and EBR-II components yielded the data which are being used for design and analysis of FFTF control elements. Boron carbide was irradiated at temperatures from 800 to 1600°F at burnup values from 2×10^{20} to 20×10^{20} captures/cm^3. A variety of material parameters such as pellet density and boron-to-carbon ratios were measured. Data on gas release, swelling, thermal conductivity, microscopy, and compatibility were found to differ substantially from data obtained in thermal reactors. (9 figures, 15 references) (auth)

15916 HIGH-TEMPERATURE OXIDATION OF TUNGSTEN BORIDE IN OXYGEN AND THE EFFECT OF SCALE EVAPORATION. Frantsevitch, I. N.; Lavrenko, V. A.; Glebov, L. A. Oxidation Metals; 6: No. 1, 1-19(Feb 1973).

The oxidation of tungsten boride in oxygen at pressures from 1 to 740 torr over the temperature range of 500 to 1200°C was studied by means of thermogravimetric, petrographic, and x-ray analyses. Kinetic parameters of the oxidation were interpreted on the basis of the Frantzevitch oxidation equation, characterizing the volatility of the phases formed, the emf of a high-temperature galvanic cell, having a gas cathode and a metal anode, and the values of the electrical resistance of the film. (auth)

15917 MASS SPECTROMETRIC STUDIES OF GASEOUS OXIDES OF RHENIUM. Skinner, H. B.; Searcy, A. W. (Univ. of California, Berkeley). J. Phys. Chem.; 77: No. 12, 1578-1585 (7 Jun 1973).

Effusion cell mass spectrometry was employed to study vapor species of the rhenium–oxygen system. The equilibrium partial pressure of $Re_2O_7(g)$ above a mixture of $Re_2O_7(s)$ and $ReO_3(s)$ from 327 to 463°K is given by $\log P(Re_2O_7) = -(7.44 \pm 0.08)10^3/T + (12.35 \pm 0.21)$ where the pressure is in atmospheres. The enthalpy of sublimation at 430°K is 34.0 ± 2 kcal/mol. Weight loss measurements show the probable composition of the dirhenium heptoxide phase in equilibrium with $ReO_3(s)$ at 400°K to be $Re_2O_{6.96 \pm 0.02}$. The reaction of rhenium with zinc oxide at 1047 at 1267°K produces $Re_2O_7(g)$, $ReO_3(g)$, and possibly $Re_2O_6(g)$. Reaction of rhenium with magnesium oxide from 1770 to 2143°K produces principally $ReO_3(g)$. The enthalpy of formation of $ReO_3(g)$ is –67.0 ± 4 kcal/mol at 298°K and that of $Re_2O_6(g)$ is ≥ –212 ± 20 kcal/mol at 298°K. $Re_2O_6(g)$, $ReO_3(g)$, and ReO(g) are not present at measurable concentrations under any of the conditions of study. The heats of formation of ReO(g) and $ReO_2(g)$ are more positive then than –10 and +48 kcal/mol, respectively. (auth)

15918 PRODUCTION OF THE A FORM OF SESQUIOXIDES OF LANTHANIDES BY ADDITION OF ThO_2. Sibieude, F. (CNRS, Odeillo, France). J. Solid State Chem.; 7: No. 1, 7-16(May 1973). (In French).

The action of ThO_2 on the hexagonal form, $A(La_2O_3)$, of certain oxides of lanthanides was examined for La_2O_3, Nd_2O_3, Pr_2O_3, Sm_2O_3, and Gd_2O_3 by means of x-ray diffraction. The existence of intermediate phases of hexagonal or rhombohedral symmetry was demonstrated for the region rich in Ln_2O_3. These phases have a structure that can be deduced from the $A(La_2O_3)$ form by stacking faults and are characterized by a high value of the parameter C. The unit cell of each intermediate compound corresponds to the superposition of a different number of cationic layers. Five compounds were found with La_2O_3: ψ_0(n layers n > 33), ψ_1(25 layers), ψ_2(15 layers), ψ_3(9 layers), and ψ_4(12 layers). Some phases of the same type are described in the case of Nd_2O_3, Pr_2O_3, and Sm_2O_3. (tr-auth)

15919 PROPERTIES OF HOT-PRESSED SiB_6. Dutta, S. K.; Gazza, G. E. (Army Materials and Mechanics Research Center, Watertown, MA). Amer. Ceram. Soc. Bull.; 52: No. 7, 552-554 (Jul 1973).

Low density, high modulus silicon hexaboride was fabricated to a final density >98% of theoretical by vacuum hot pressing at 1600 ± 10°C and 6000 psi. Densification behavior was studied as a function of hot-pressing temperature. The operation was successfully scaled up to 4 in. diameter compacts with a final density >98% of theoretical. The microstructure consisted of more than two phases containing SiB_6, SiB_4, and Si, which could be attributed to the presence of impurities, poor stoichiometry, and chemical composition in the "as-received" starting materials. The microhardness, diametral compression strength and transverse bend strength were determined. A maximum bend strength of 28,000 psi was obtained by four-point loading system, while an average modulus of elasticity was calculated to be 41 to 43×10^6 psi. Fracture surfaces indicated mostly concoidal-type fracture mixed with transgranular fracture. It was concluded that the data is representative of the polyphase material tested of which SiB_6 is the principal phase. (auth)

15920 CERMOTHERM, NEW MATERIAL FOR EXTRUSION DIES. Copper (Geneva); No. 1, 10-11(1973).

Properties of Mo–ZrO_2 Cermotherm cermets for use in extrusion dies are reported. The material is suitable for use in extrusion dies for a large number of metals and alloys. It may also be usable in dies for alloys which previously could not be extruded. (JRD)

15921 PREPARATION OF ALUMINUM NITRIDE. Seifert, S.; Hladik, O. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 8: No. 6, 233-234(Jun 1972). (In German).

To produce large amounts of pure aluminum nitride for the $^{14}N(n,p)^{14}C$ reaction, a modified Charlton–Evans method was developed. In a perpendicular tube of 10 cm diameter, four floors of nickel were inserted. On these, a mixture of 400 g aluminum powder with 20 g potassium hydrofluoride was evenly distributed. The reaction tube then was heated and continuously flushed by a stream of nitrogen, to which argon was added for control of the reaction rate. The final product showed 95% aluminum nitride; 5% aluminum oxide. (HBG)

15922 APPARATUS FOR STUDYING THE KINETICS OF HIGH TEMPERATURE REACTIONS OF MATERIALS WITH ATOMIC AND MOLECULAR GASES AND THE BEHAVIOUR OF MATERIALS IN VACUUM. Glebov, L. A.; Lavrenko, V. A.; Timoshenko, V. M. (Inst. of Materials Science, Kiev). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 8, 1219-1220(Aug 1972).

Translated from Zh. Fiz. Khim.; 46: No. 8, 2133-2134(Aug 1972).

The apparatus can be used to study the kinetics of the reactions between solids and the controlled gaseous environment of a vacuum microbalance in the pressure range between 0.2 and 700 torr, and also the behavior of materials in vacuum at temperatures between room temperature and 1500°K. The active components of the gases (atoms, excited atoms, ions) are produced by means of a high-frequency generator. The method is suitable for studies of scale formation on chromium and zirconium borides in pure oxygen at 1473°K and 740 torr. (auth)

15923 IS THE MANUFACTURE OF UO_2 FUEL RODS WITH ZIRCALOY CLADDING INDUSTRIALLY ESTABLISHED? Hausner, H. (Technische Univ., Berlin). Atomwirt., Atomtech.; 18: No. 4, 168-170(1973). (In German).

From first technical conference of the fuel element group of the KTG; Karlsruhe, Ger. (13 Nov 1972).

The Fuel Element Group of the KTG organized their first technical conference in the form of a discussion of various topical questions on the fuel cycle which they themselves put to the meeting. Each question was dealt with by one or two speakers and finally by a panel in a discussion with the participants. The third question of the series dealt with the technical status and the competition in the manufacture of UO_2 fuel elements with Zircaloy cladding in the German Federal Republic. Although the German fuel element manufacturers and the manufacturers of Zircaloy cladding tubes have considerable experience and are able to supply the nuclear power stations of the German utility companies with any desired quality and quantity, it is still only possible to answer the question whether this manufacture is industrially established with a qualified affirmative. An absolute affirmative will only be possible when future annual capacities of at least 1,000 tons are attained in the case of fuel elements. (GE)

15924 PRODUCTION OF CUBIC SOLID SOLUTIONS OF Y_2O_3 IN ZrO_2 BY MEANS OF ORGANOMETALLIC COMPOUNDS. Ioffe, A. I.; Strekalovskii, V. N.; Rutman, D. S.; Karpachev, S. V. (Inst. of Electrochemistry, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR; 209: No. 3, 646-647(1973). (In Russian).

Solid solutions of Y_2O_3 in ZrO_2 were formed from oxide mixtures obtained by the hydrolysis of Y and Zr alcoholates. Isopropylates were first formed from $ZrCl_4$ (5°C) and metallic Y (reaction at 82°C) and isopropanol. X-ray diffraction patterns and microstructure photographs were made which yielded data on the interplanar distances of the cubic Y_2O_3–ZrO_2 solid solution. (KSW)

15925 ENTHALPY OF SODIUM OXIDE Na_2O TO 1300 K BY DROP CALORIMETRY. Fredrickson, D. R.; Chasanov, M. G. (Argonne National Lab., IL). J. Chem. Thermodyn.; 5: No. 4, 485-490(Jul 1973).

A high-precision drop-calorimetric system has been used to measure the enthalpy (relative to 298.15 K) of Na_2O in the temperature range 500 to 1300°K. A rapid rise in the derived $C_p(T)$ is observed above 900°K, which may be attributed to the onset of a diffuse transition in Na_2O and a disordering of the Na^+ ions. The results are therefore represented by two equations, one for temperatures below 900°K and another for temperatures above 900°K.

In the range 298 to 900°K: $\{H^0(T) - H^0(298.15\ K)\}/cal_{th}\,mol^{-1} = 13.8814(T/K) + 4.4249 \times 10^{-3}(T/K)^2 - 4532.09$. In the range 900 to 1300°K: $\{H^0(T) - H^0(298.15\ K)\}/cal_{th}\,mol^{-1} = 35.4157(T/K) - 2.80046 \times 10^{-2}(T/K)^2 + 1.42549 \times 10^{-5}(T/K)^3 - 8036.87$. All temperatures are based on IPTS-68. Values of $\{H^0(T) - H^0(298.15\ K)\}$, $C^0_p(T)$, $\{S^0(T) - S^0(298.15\ K)\}$, $\Delta H^0_f(T)$, $\Delta G^0_f(T)$, and log $K^0_p(T)$ are tabulated. (auth)

15926 DIFFUSION CORRELATION EFFECTS IN NONSTOICHIOMETRIC SOLIDS. De Bruin, H. J.; Murch, G. E. (Flinders Univ. of S. Australia, Bedford Park). Phil. Mag.; 27: No. 6, 1475-1488(Jun 1973).

Diffusion in lattice arrays reducible to cubic symmetry can be simulated by Monte Carlo procedures. Tracer correlation factors can be derived for diffusion mechanisms in such arrays which include simple solids with point defects and non-stoichiometric materials with complex defect structures subject to defect–defect interactions. It is shown that such interactions can substantially reduce the correlation factor. A cooperative diffusion mechanism involving Willis 2:2:2 defect clusters in UO_{2+x} is shown to have a correlation factor greater than unity. (auth)

15927 HIGH-TEMPERATURE CALORIMETRY IN METAL + HYDROGEN SYSTEMS. 1. Ta + H_2 at 703 K. Kleppa, O. J.; Melnichak, W. E.; Charlu, T. V. (Univ. of Chicago). J. Chem. Thermodyn.; 5: No. 4, 595-602(Jul 1973).

The partial enthalpies of solution of hydrogen in Ta + H solid solutions were measured under near equilibrium conditions at 700°K by microcalorimetry. The results are compared with similar data in the literature derived from equilibrium work. They suggest that precision high-temperature calorimetry should be a very powerful technique for detailed studies of the thermodynamics of metal + hydrogen systems. (auth)

15928 VACANCY ORDERING IN VANADIUM CARBIDES BASED ON V_6C_5. Hiraga, K. (Tohoku Univ., Sendai). Phil. Mag.; 27: No. 6, 1301-1312(Jun 1973).

The ordered arrangement of carbon vacancies in vanadium carbides near V_6C_5 has been analyzed by means of selected-area electron diffraction and high-voltage electron microscopy. A new type of ordered distribution of carbon vacancies is found at non-stoichiometric compositions between V_6C_5 and V_8C_7. This structure can be expressed as a long-period structure consisting of the enantiomorphic domains based on the structure V_6C_5 which was determined by Billingham, J., Bell, P. S. and Lewis, M. H. (Phil. Mag., 25: 661(1972)). The periodic domain boundaries with spacing eleven times the nearest-neighbor interatomic distance are directly observed by electron microscopy. (auth)

15929 THERMODYNAMIC ANALYSIS OF THE PRODUCTION OF TUNGSTEN CARBIDES IN A VACUUM. Syrkin, V. G.; Uel'skii, A. A. Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 9, 1273-1275(Sep 1972).

Translated from Zh. Fiz. Khim.; 46: No. 9, 2229-2232(Sep 1972).

A thermodynamic analysis has been made of several side reactions in the thermal decompositon of tungsten hexacarbonyl in vacua down to 0.0001 atm at 600 to 1400°K. The probability of these reactions is shown to diminish with increase in the vacuum at constant temperature. (auth)

15930 THERMAL CONDUCTIVITY OF SOME REFRACTORY CARBIDES AND BORIDES. L'vov, S. N.; Lesnaya, M. I.; Vinitskii, I. M.; Naumenko, V. Ya. (Inst. of Problems in Materials, Science, Kiev). High Temp. (USSR) (Engl. Transl.); 10: No. 6, 1196-1198(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 6, 1327-1329 (1972).

The results of an investigation of the temperature dependences of thermal conductivity of the carbides TiC, ZrC, NbC, TaC, Cr_3C_2, Mo_2C, and WC and of the borides TiB_2, VB_2, CrB_2, Mo_2B_5, and W_2B_5 in the temperature range 300–1200°K are reported. Data on the temperature dependences of the thermal conductivity of all the borides and of the carbides Cr_3C_2, Mo_2C, and WC are new. (auth)

15931 THERMAL CONDUCTIVITY OF DIBORIDES OF GROUP IV–VI TRANSITION METALS. Samsonov, G. V.; Kovenskaya, B. A.; Serebryakova, T. I.; Tel'nikov, E. Ya. (Inst. of Problems in Materials Science, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 6, 1324-1326(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 6, 1324-1326 (1972).

The results obtained demonstrate that the thermal conductivity rises with temperature because the electron component becomes larger. The rise of λ_e with increasing temperature has been reported in other investigations and can be attributed to a reduction in the effective carrier mass ($\lambda \sim 1/m^*$). It is worth noting the considerable contribution of the phonon component to the total thermal conductivity, which is probably due to the presence of a large fraction of localized hybrid sp states of the boron atoms forming predominantly covalent bonds between these atoms. Experimental studies justify the hypothesis of a higher degree of localization of the electron states of the boron atoms in diborides of group IV transition metals, compared with diborides of group V and VI metals. The presence of more rigid atomic bonds in the lattices of group IV diborides should reduce the phonon–phonon and electron–phonon scattering and give rise to higher values of the phonon and electron components of the thermal conductivity. The observed tendency for the phonon thermal conductivity to decrease with increasing average atomic weight is in agreement with the theory. (auth)

15932 DETERMINATION OF EXCESS ENERGY OF VARIOUS FORMS OF DISPERSE CARBON FROM EQUILIBRIA IN METAL CARBIDE–NITRIDE–CARBON–NITROGEN (MC–MN–C–N) SYSTEMS. Levinskii, Yu. V. Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 9, 1261-1263(Sep 1972).

Translated from Zh. Fiz. Khim.; 46: No. 9, 2206-2209(Sep 1972).

The excess free energy of various forms of carbon has been calculated from experimental results for the equilibrium in MC–MN–C–N systems (M = Ti, Zr, Hf, V). The excess free energies of lampblack and of finely disperse carbon formed by the action of nitrogen on carbides are respectively 0.58 ± 0.40 and 1.25 ± 1.00 kcal $mole^{-1}$ relative to spectroscopic graphite. Differences in the state of carbon in equilibrium with carbidenitride systems of high-melting metals may be the reason for differences of 2 to 4 mole % in the composition of the equilibrium solid solution. (auth)

15933 LOW-TEMPERATURE INTERNAL FRICTION IN BORON FIBERS. Dugladze, G. M.; Darsavelidze, G. Sh.; Tsagareishvili, G. V.; Tavadze, F. N. (Inst. of Metallurgy, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 69: No. 2, 397-400(Feb 1973). (In Russian).

At 128°K a relaxation maximum with the activation energy 0.64 eV was found. The change of the height and form of the maximum has been studied in its dependence on the fiber diameter and purity. It is suggested that the origin of the maximum is connected with impurity displacement in a periodically applied elastic field. (auth)

15934 EVALUATION OF IRRADIATED FUEL RODS WITH PULSED EDDY CURRENTS. Asamoto, R. R.; Bacon, R. F.; Conti, A. E.; Wozadlo, G. P. (General Electric Co., Sunnyvale, CA). Mater. Eval.; 31: No. 4, 67-72(Apr 1973).

Fuel rods irradiated to 55,000 MWd/t in EBR-II were nondestructively inspected, utilizing pulsed eddy currents. The data were evaluated, and metallography of suspect areas was investigated. Correlations were made between pulsed eddy current signals and irradiation-related occurrences observed in the mixed (uranium-plutonium) oxide, stainless-steel-clad fuel rod. The pulsed eddy current technique employed indicated the radial location of discontinuities on the fuel cladding wall, showing the axial and angular orientation of the discontinuity, and was sensitive to surface irregularities 0.006 mm (0.2 mil) in depth. The pulsed eddy current system provides a powerful nondestructive tool for effectively characterizing and economically aiding in the evaluation of irradiated fuel rods prior to destructive examination or on an interim basis. (auth)

15935 ELECTRICAL TRANSPORT PROPERTIES OF THE ALLOY $(V_{0.3}Nb_{0.7})O_2$. Kristensen, I. K. (Institute of Physics, Odense University, Denmark). J. Appl. Phys.; 44: No. 5, 2428-2429(May 1973).

Measurements of the electrical conductivity and the Seebeck effect in $(V_{0.3}Nb_{0.3})O_2$ are reported. A semiconductor-to-metal transition is observed at about 1000°K and an evaluation of the activation energy for the electron mobility gives 0.5 eV. (auth)

15936 ENERGY BANDS OF METALLIC VO_2. Caruthers, Ed; Kleinman, Leopard; Zhang, H. I. (Department of Physics, University of Texas, Austin, Texas 78712). Phys. Rev. B 7: No. 8, 3753-3760 (15 Apr 1973).

At 68 °C, VO_2 undergoes a phase transition from a semiconductor with monoclinic structure to a rather poor metal with the rutile structure. We have performed a modified-augmented-plane-wave (APW) calculation for the metal phase, using a semiempirical potential chosen to give agreement with the experimentally determined energy difference between the top of the O_{2p} band and the Fermi surface. A tight-binding parametrized linear-combination-of-atomic-orbitals calculation was fitted to the three points in the Brillouin zone where APW energy levels were calculated, and the resultant energy bands and density of states are presented. Our results indicate that the poor conductivity is due to the flatness of the lower d bands (and perhaps

correlation effects) and not to any semimetallic nature of the energy bands. We also discuss the molecular-orbital picture of rutile TiO_2 and VO_2. (auth)

15937 ENERGY BANDS OF SEMICONDUCTING VO_2. Caruthers, Ed; Kleinman, Leonard (Department of Physics, University of Texas, Austin, Texas 78712). Phys. Rev. B 7: No. 8, 3760-3766 (15 Apr 1973).

For $T > T_t \simeq 68$ ° C, VO_2 is a metal with the rutile structure. For $T < T_t$, VO_2 is a semiconductor with a monoclinic structure. We have found semiconducting energy bands for the low-temperature structure from a parametrized tight-binding linear-combination-of-atomic-orbitals calculation. The semiconducting gap results not only from the reduced symmetry of the monoclinic phase but also from changes in the tight-binding parameters which result from changed interatomic distances. The joint density of states derived from our calculation is in very good agreement with experimental optical data. The success of this calculation shows that, given the crystal structure, the semiconducting band gap is completely understandable in terms of one-electron theory. A short Appendix on the group theory of this structure is included. (auth)

Metals and Alloys

Refer also to abstracts 15267, 15413, 15428, and 15922.

15938 (ORNL-4832, pp 62-156) PART 3. MATERIALS DEVELOPMENT. McCoy, H. E. Mar 1973. Molten-Salt Reactor Program Semiannual Progress Report for Period Ending August 31, 1972.

Work was done on (1) intergranular cracking of Hastelloy N in the MSRE fuel system and its control in future reactors, (2) development of a graphite with improved dimensional stability under radiation, (3) development of surface sealing methods for reducing the permeability of graphite to ^{135}Xe, (4) modification of Hastelloy N for improved resistance to neutron irradiation, (5) evaluation of Hastelloy N for use in steam generators, (6) construction of a molybdenum system for use with bismuth and fluoride salts, and (7) evaluation of other structural materials for chemical processing plants. (DLC)

15939 STRUKTURA I SVOISTVA LEGKIKH SPLAVOV. (Structure and Properties of Light Alloys). Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). 150p.

The thirty papers deal with physicochemical investigations of light and nonferrous alloys, aimed at the development of methods for obtaining alloys with specific properties. The principal issues studied are the construction of binary and ternary phase diagrams; the influence of alloying elements on the structure and properties of alloys; the study of reduction, crystallization, and recrystallization processes; and the decomposition of supersaturated solid solutions. The relationship between the mechanical, physical, and other properties of alloys and their structure, and the conditions for obtaining a specific structure are investigated. Phase composition diagrams and the effect on various properties of alloying were examined in connection with the following metals of special interest here: Nd, Zr, Y, Ce, Pr, La, Cd, and Mo. Separate abstracts have been prepared for ten of the papers. (KSW)

For abstracts of individual chapters see: 15988, 15989, and 16026-16033.

15940 OPPORTUNITIES IN MATERIALS. Proceedings of the Fourth Buhl International Conference on Materials, Pittsburgh, Pennsylvania, November 16-18, 1971. Shaw, M. C. (ed.). Pittsburgh; Carnegie Press (1971). 505p. (CONF-711154-).

Abstracts were prepared for three papers from a total of fifteen papers concerned with new developments in a wide variety of materials including metals, glasses, ceramics, polymers, and electrical materials. The second section of the proceedings included nine papers devoted to opportunities in waste product utilization and recycling technology. (MCW)

For abstracts of individual papers see: 16039-16041.

15941 FRACTURE: AN ADVANCED TREATISE. Volume VII. Fracture of Nonmetals and Composites. Liebowitz, H. (Ed.). New York; Academic Press, Inc. (1972). 1062p. $65.00.

The book comprises twelve chapters. A separate abstract was prepared for each of three chapters. The remaining chapters were not in the scope of NSA. (JRD)

For abstracts of individual chapters see: 15903, 15904, and 16134.

Corrosion and Erosion

Refer also to abstracts 15854, 17458, 17466, 17492, and 17493.

15942 (AGARD-CP-120) SPECIALIST MEETING ON HIGH-TEMPERATURE CORROSION OF AEROSPACE ALLOYS, LYNGBY, DENMARK, APRIL 10-12, 1972. Stringer, J.; Jaffee, R. I.; Kearns, T. F. (eds.). (Advisory Group for Aerospace Research and Development, Paris (France)). 1973. 356p. (CONF-720474-).

Approximately fifty-eight papers were presented at the conference. A separate abstract was prepared for each of three papers. Papers for which no abstracts were prepared are concerned with materials in high-temperature environments, oxidation of superalloys, and uses of coated refractory alloys. (JRD)

For abstracts of individual papers see: 15841, 15943, and 15944.

15943 (AGARD-CP-120, pp 221-233) WHAT ARE THE EFFECTS OF ALLOYING ELEMENTS SINGLY OR IN COMBINATION ON HOT CORROSION? Davin, A.; Coutsouradis, D. 1973.

From specialist meeting on high temperature corrosion of aerospace alloys; Lyngby, Denmark (10 Apr 1972).

As single additions, only chromium or aluminum appears to improve the oxidation resistance of nickel and cobalt appreciably due to the formation of protective scales of Cr_2O_3 and Al_2O_3, respectively, at sufficiently high concentrations. When the two elements are added together, the presence of the chromium causes a stable layer of Al_2O_3 to develop at lower aluminum concentrations than in the binary systems, due to the gettering effect of the chromium in the metal impeding the inward diffusion of oxygen and thus preventing internal oxidation of the aluminum. Tantalum additions are beneficial in the oxidation of Co-Cr alloys but have little effect on the sulfidation resistance. Molybdenum and tungsten additions have a deleterious effect on the oxidation resistance of Co-Cr alloys at all temperatures, apparently due to the formation of low melting point compound oxides. Again there appears to be little effect on sulfidation resistance. Rare-earth additions increase the oxidation resistance of Ni- or Co-base superalloys, and are also reported to be beneficial in hot corrosion. (auth)

15944 (AGARD-CP-120, pp 283-294) ARE THERE NEW APPROACHES TO ALLOYING WHICH MAY PRODUCE OXIDATION-RESISTANT REFRACTORY METAL ALLOYS? Stringer, J. (Univ. of Liverpool). 1973.

From specialist meeting on high temperature corrosion of aerospace alloys; Lyngby, Denmark (10 Apr 1972).

The oxidation mechanisms of Nb, Ta, Mo and W are briefly reviewed. Nb and Ta form nonprotective porous scales of the pentoxides and, at the same time, oxygen dissolves in the metal producing severe embrittlement. Reduction of the overall oxidation rate by alloying could thus be achieved if the failure of the pentoxide could be inhibited but, in practice, this does not appear to be possible, and it is necessary to add elements that encourage the formation of another oxide with an intrinsically lower transport rate. In the case of niobium, the most promising bases are the systems Nb-Ti-W and Nb-Al-V; but notable further improvements can be achieved by adding a relatively small amount of Ni, Fe or Co, and the reason for this is not well understood. At elevated temperatures, both Mo and W form volatile oxides, and reduction in the oxidation rate requires the stabilization of a foreign oxide or the development of a protective noble metal-rich layer at the surface. Some molybdates and tungstates appear to have promising properties, and chromium-rich alloys forming Cr_2O_3 layers also represent significant improvements. Unfortunately, all alloys so far developed which have significantly improved oxidation resistance are also very brittle. (auth)

15945 (AI-AEC-13083) HASTELLOY X CLADDING MATERIAL EVALUATION. Moore, K. E.; Brengle, R. G.; Parker, T. G. Jr. (Atomics International Div., Canoga Park, Calif. (USA)). 15 Jun 1973. Contract AT(04-3)-701. 57p. Dep. NTIS $5.00.

Hastelloy X is the reference fuel element cladding for the 5-kWe space power reactor. The effects of fuel element processing, and exposure to the reactor environment, were evaluated by conducting mechanical property and corrosion tests on three heats of Hastelloy X in various heat-treat conditions. Mechanical properties of processed material are in good agreement with literature values. Some ductility loss was observed in tensile tests. This is attributed to interstitial contamination resulting from the SCB ceramic hydrogen barrier coating process. Hastelloy X samples were exposed to flowing 1400°F NaK in a loop operated with a 90°F ΔT to obtain accelerated corrosion effects. The exposed surfaces of these samples were affected to a depth of ~2 mils after 2000 h. The affected area had lost chromium, and contained intergranular microvoiding. Results of biaxial stress-rupture tests, performed in flowing NaK at 1300°F, indicate no significant effect on properties. Creep tests were performed on unirradiated and irradiated material. Irradiated material showed slightly

greater creep strength; ductilities were 1.0% or higher. Transmission electron microscopy was performed on processed and aged Hastelloy X. Only slight differences in precipitation reactions could be attributed to the processing environment. The predominant phase resulting from thermal aging at 1200 and 1300°F was found to be M_6C. (auth)

15946 (EURFNR-1081) STUDIES ON THE REACTIVITY OF VANADIUM ALLOYS WITH SIMULATED FISSION PRODUCTS IN THE PRESENCE OF UO_2 AND UC. Hofmann, P.; Goetzmann, O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jan 1973. 80p. (KFK-1718). Dep. NTIS $6.00.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The two vanadium-base alloys VTi3Si1 and VZr2Cr15 were tested in contact with various fission-product elements at temperatures between 600 and 900°C and annealing times of 1000 hours. The tests were made with pure fission-product elements, groups of such elements, and mixtures of oxide nuclear fuel of various O/M ratios and fission product elements, as well as similar mixtures with carbide nuclear fuel of different carbon contents. Metallography and electron-microprobe analyses were employed in the post-annealing investigation. The results are documented by many micrographs and microprobe pictures. These tests should be regarded in connection with similar tests on steels, which are described in an earlier report. Vanadium alloys are more resistant against fission-product attack than stainless steels. Cesium is dangerous only if the alloy contains chromium. The dissolution of alloy components in tellurium and selenium is quite rapid at 800°C. There is only a slight attack of iodine and bromine at this temperature. Cladding attack by fission products was much less when these elements were mixed with fuel in concentrations corresponding to a burnup of 10 at.%. Blended with UC the fission product–cladding material interactions even disappeared. Embrittlement of vanadium alloys by oxygen uptake from the fuel seems to be more severe than reactions with fission products. Hardening of the vanadium cladding by carbon was observed only when annealed in contact with hyperstoichiometric UC. In some cases it could be shown that carburization was reduced by the presence of fission-product elements. (auth)

15947 (NAA-SR-9007) SNAP FUEL AND CORE MATERIALS COMPATIBILITY SCREENING TESTS. Lundberg, L. B. (Atomics International, Canoga Park, Calif.). 1 Mar 1964. Contract AT(11-1)-GEN-8. 35p. Dep. NTIS $3.75.

Declassified 3 May 1973.

Screening tests were performed to determine the compatibility of many of the materials in contact with each other in the SNAP 10A/2 and SNAP 8 reactor cores. In some cases of known incompatibility, reaction barriers were studied. The tests involved placing small samples of the materials under consideration in intimate contact at temperatures from 1200 to 1450°F for periods up to 1000 h in environments similar to those encountered in the particular reactor. The mutual compatibility of the sample materials was determined by metallographic examination. Reactions were observed between the following components: fuel and the bare cladding (without hydrogen barrier); fuel cladding and the SNAP 2 beryllium internal radial reflector; and several fuel element thermal bond materials and both the fuel and the enamel hydrogen barrier. Reaction barriers for fuel cladding and the SNAP 2 beryllium internal radial reflector were examined, but none were found to be effective. The majority of the suggested reactor core materials were found compatible. (auth)

15948 (ORNL-TM-4174) POST-IRRADIATION EXAMINATION OF MATERIALS FROM THE MSRE. McCoy, H. E.; McNabb, B. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 110p. Dep. NTIS $7.50.

The Molten-Salt Reactor Experiment operated very successfully. The fuel loop was above 500°C for 30,807 h and contained fuel salt for 21,040 h. A surveillance program was active during operation to follow the property changes of the graphite moderator and the INOR-8 structural material. After operation was discontinued in December 1969, several components were removed for examination. These included a graphite moderator element from the core, a control rod thimble, freeze valve 105, the sample cage and mist shield from the fuel salt pump bowl, a copper sampler capsule, tubes and a portion of the shell of the primary heat exchanger, and tubes and two thermocouple wells from the air-cooled radiator. Examination of these materials showed excellent mutual chemical compatibility between the salts, graphite, and INOR-8. The INOR-8 exposed to fuel salt formed shallow intergranular cracks believed to be due to the ingress of the fission product tellurium. The INOR-8 was also embrittled by exposure to thermal neutrons, and this was attributed to the formation of helium by the $^{10}B(n,\alpha)^{7}Li$ transmutation. (auth)

15949 (ORNL-TM-4189) EVALUATION OF HASTELLOY N ALLOYS AFTER NINE YEARS EXPOSURE TO BOTH A MOLTEN FLUORIDE SALT AND AIR AT TEMPERATURES FROM 700 TO 560°C. Koger, J. W. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 39p. Dep. NTIS $4.00.

A Hastelloy N thermal-convection loop, some portions of which consisted of a Hastelloy N alloy modified with 2% Nb for improved weld properties and containing LiF–23 mole % BeF_2–5 mole % ZrF_4–1 mole % UF_4–1 mole % ThF_4, was operated for 9.2 years at a maximum temperature of 700°C and a minimum of 560°C. Loop operation ended with the occurrence of a salt leak. The failure of the loop was attributed to a reaction between impurities in a ceramic bushing and the modified Hastelloy N–2% Nb tubing. Microscopic examination of the loop tubing revealed that mass transfer of material (material removal and deposition) did occur. The attack, which occurred in the hot section, was manifested in the formation of voids, in a zone of maximum depth of 4 mils. Deposition was noted on the colder portions. On the basis of salt analysis and microprobe analysis of the tubing, the mass transfer appeared to be selective with respect to chromium, which is what would be predicted from thermodynamic considerations. The actual void formation and chromium depletion agrees favorably with that predicted from calculations. No difference in corrosion could be seen in the standard Hastelloy N and the modified Hastelloy N–2% Nb alloy. No change in mass transfer could be seen in the welded areas. A two-layer oxide of 2 mils thickness was the maximum formed under the heaters in 9.2 years exposure to air. Hastelloy N is much more resistant to mass transfer than type 304L stainless steel exposed to the same salt under similar conditions. It was concluded from this experiment that Hastelloy N is suitable for long-term use as a container material for the molten salt used in this test and has acceptable air oxidation resistance at the temperatures tested. (auth)

15950 (SGAE-2126) KINETIC ASPECTS OF THE CORROSION OF AUSTENITIC STAINLESS STEEL IN HIGH-TEMPERATURE SODIUM. Schwarz, N.; Rajakovics, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.M.B.H., Seibersdorf). Apr 1973. 19p. (CONF-730449-1). Dep. NTIS (U. S. Sales Only) $3.00.

Weight-change measurements of austenitic stainless steel in sodium of representative hot-spot conditions of an LMFBR (e.g., 730°C, low oxygen content) showed small steady-state corrosion rates. Weight losses and their correlation to surface morphology is demonstrated with SEM photography. Experimental findings suggest that an apparent velocity dependency and the so called "down-stream-effect" can be attributed mainly to these selective phenomena. (auth)

15951 OXIDATION OF Nb–Ti–Al ALLOYS AT HIGH TEMPERATURES. Lazarev, E. M.; Vasil'eva, E. V.; Prokoshkin, D. A.; Vasil'eva, A. I. J. Appl. Chem. USSR (Engl. Transl.); 46: No. 1, 45-48(Jan 1973).

Translated from Zh. Prikl. Khim.; 46: No. 1, 48-52(Jan 1973).

Study of the oxidation kinetics of alloys of niobium with a constant titanium content (25 wt %) and variable aluminum contents (1 to 15 wt %) in the temperature range 900 to 1200°C in air during 300 to 750 h showed that niobium alloys alloyed with 8 to 10 wt % of aluminum have the highest heat resistance. The higher heat resistance of these alloys is due to the presence of the close-packed oxides TiO_2 and Al_2O_3 in the scale, and to formation of solid solutions of these oxides with Nb_2O_5 and of the compounds $Nb_2O_5 \cdot TiO_2$ in the scale; the structure of these products is less favorable for diffusion of oxygen ions than the lattice of unalloyed niobium pentoxide. (auth)

15952 ANALYSIS OF CORROSION OF STEELS BY LIQUID SODIUM. Roy, P.; Schad, M. K. (General Electric Co., Sunnyvale, CA). Contract AT(04-3)-189. J. Nucl. Mater.; 47: No. 1, 129-131(May 1973).

Data on the effect of velocity of sodium on corrosion of (stainless) steels are reviewed. A plot of corrosion rate vs thickness of laminar sublayer shows that the corrosion rate becomes independent of fluid turbulence below a boundary layer thickness of 0.0002 in. (DLC)

15953 KINETICS OF CARBON TRANSFER GOVERNING COMPATIBILITY BETWEEN URANIUM CARBIDE AND STAINLESS STEEL BONDED WITH SODIUM. Nishio, G.; Shimokawa, J. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 47: No. 1, 87-94(May 1973).

Hyperstoichiometric uranium carbide containing ^{14}C (6.0 wt %) and stainless steel (AISI 304) specimens were enclosed in a nickel capsule together with sodium, and then heated to 750°C. With respect to the degree of carburization of the stainless steel, the ^{14}C activity in the steel decreased exponentially with depth and increased with heating time. The kinetics of carbon transfer was

well interpreted by assuming that carbon atoms leached out into sodium from UC_2 platelets in the carbide and then diffused into the stainless steel along its grain boundary. (9 figures) (auth)

15954 MORPHOLOGY OF THICK OXIDE FILMS ON ZIRCALOY-2. Cox, B.; Donner, A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 47: No. 1, 72-78(May 1973).

The layered structure observed commonly in post-transition oxide films formed on Zircaloy-2 is shown to consist of alternate layers of large and small oxide crystallites. The undisturbed oxide probably contains no lateral cracks and (in oxides up to ~10 μm) few cracks perpendicular to the surface. However, the weakness represented by the alternating layers of differently sized crystallites makes the oxide susceptible to easy fracture along the boundary between these layers, so that most metallographic techniques produce a pattern of cracks which were probably not present in the original specimen. The absence of lateral cracking in even one specimen of Zircaloy-2 implies that such a process cannot be a general explanation for the oxidation rate transition, and that an alternative mechanism for the generation of porosity in the oxide is more probable. Results are also given for unalloyed zirconium for comparison purposes. (6 figures, 16 references) (auth)

15955 INFLUENCE OF V, Cr, AND C ADDITIONS ON THE ELECTROCHEMICAL BEHAVIOR OF URANIUM IN ACID MEDIA. Pommier, G.; Jouve, G.; Aucouturier, M.; Lacombe, P. (Paris Univ., Orsay, France). J. Nucl. Mater.; 47: No. 1, 1-6(May 1973). (In French).

The influence of vanadium, chromium, and carbon on the electrochemical behaviour of uranium in an aqueous medium, at an acid pH, is shown by tracing polarization curves for U–0.2% V and U–0.2% Cr alloys. For U–0.2% V, the critical potential becomes more negative as the pH changes from 0 to 4; concurrently, the critical current density increases substantially. For the U–0.2% Cr alloy, the polarization curve changes in the opposite manner, i.e., the critical current density decreases as the pH goes up. A phenomenological interpretation is advanced concerning the difference of the solute elements, Cr and V, on the value of the overpotential on the anodic curve. Carbon (examined in connection with U–0.2% V) affects only the cathodic overpotential for hydrogen reduction. The investigation was completed by a study of the nature of the phases formed, using electron diffraction at glancing incidence. (auth)

15956 HEAT-TRANSFER CHARACTERISTICS OF ZIRCALOY-2 OXIDE FILM. Maki, H. (Hitachi Ltd., Ibaraki, Japan). J. Nucl. Sci. Technol. (Tokyo); 10: No. 3, 170-175(Mar 1973).

Oxide film was made to form on the outside surface of Zircaloy-2 tube (inside diameter = 12.672 mm, wall thickness = 0.826 mm) under the following three different conditions, (a) 300°C saturated LiOH solution, (b) 450°C and 15 ata steam, and (c) 450°C air. The resulting oxide presented colors ranging from white to black, depending on the oxidation temperature and duration of exposure. Each of these oxidized specimens, together with a control specimen (unoxidized), was heated directly by alternating current in high-temperature coolant water sealed in an autoclave. The apparent thermal conductivity of the oxide film was obtained by comparison of the temperatures inside tube measured on the oxidized and clean specimens under conditions as similar as possible. The experiment was conducted using 110, 150, 200, 250, and 300°C coolant temperatures. Near 110°C coolant temperature, the apparent thermal conductivity was not affected significantly by differences in the oxidation method, and the values obtained were distinctly lower than that of sintered ZrO_2 stabilized with CaO. At higher temperatures, the oxide films formed under different conditions each showed individual heat transfer characteristics. The apparent thermal conductivity of white oxide film was smaller than that of black oxide film at near 300°C of coolant temperature. (auth)

15957 RESISTANCE OF ANODIC FILMS ON TITANIUM AND SOME TITANIUM ALLOYS. Radovici, O.; Popa, M. V. Rev. Coroz.; 1: No. 1, 9-15(1971). (In Rumanian).

A potentiostatic method was used to study the resistance of passive anodic films on Ti, Ti + Mo, Ti + Ni, Ti + Pd, and Ti + V in calcium halide solutions at temperatures above 100°C. A passive film on a working electrode surface was found to have a fairly high resistance of approximately 10 to 12 V, which is lower than in an acidic medium. Passive film break-down potential was shown to depend on temperature and on the nature of the alloy and halogen ion. The alloys were resistant over a wide potential range, the most resistant being Ti + Ni. (Corros. Control Abstr.)

15958 METHOD OF APPLYING DIFFUSION (ANTICORROSION) COATING TO ARTICLES OF REFRACTORY METALS. Argyriades, D.; Carter, G. F. (to E. I. du Pont de Nemours and Co.). Danish Patent 118,052. 28 Dec 1970. Filed date 27 Dec 1963.

A method is described for applying to W, Mo, Cr, Nb, V and Ta articles a diffusion coating of Al and/or Si, and also Ti, Mn, Fe, Co, Ni, Y, and Zr for protection against oxidation at high temperatures. A workpiece is immersed for 1 to 4 h in a neutral bath of Ca, Ba and/or Sr, containing Al and/or Si at 900 to 1450°C in a protective Ar or He atmosphere. Al gives the most oxidation-resistant coating and Ni the coating most resistant to nitrogen saturation. A film is obtained with a thickness up to 62.5 μ and a diffused metal content falling from 20 to 30% to zero. In tests in air at 1050°C over 47 to 125 h, coatings of Al on Nb, having a phase structure varying with depth from $NbAl_3$ to Nb_2Al and high elasticity, proved extremely stable. Coatings of V, Cr, Mo, Nb, Ta and W are possible for special purposes. (Corros. Control Abstr.)

15959 ENVIRONMENT, APPLICATION, COST, AND FUTURE. IV. Toth, I. J.; Brentnall, W. D.; Menke, G. D. J. Metals; 24: No. 12, 37-42(Dec 1972).

The summary includes data on aluminum composites for environmental conditions, aerospace applications, composite costs, and future directions of research. Data on aluminum composites where corrosion, erosion, and thermal stability are important are studied with reference toward aerospace applications where the high initial costs can be justified in terms of performance. The aerospace applications are being developed in gas-turbine engines, aircraft structures, and space vehicles. Examples of B–Al compositions are shown for such items as box skins, ribs, spars, fasteners, and honeycomb facings. Some desirable characteristics include thermal conductivity; electrical conductivity; the ability to accept special finishes, such as low-emittance temperature-control polishes or bright electroplates; low gas permeability; and relatively high transverse strengths and elastic modulus for the unidirectional material. (101 references) (MCW)

15960 MECHANISM OF URANIUM DIOXIDE–SODIUM EXPLOSIVE INTERACTIONS. Fauske, H. K. (Argonne National Lab., IL). Nucl. Sci. Eng.; 51: No. 2, 95-101(Jun 1973).

A mechanism believed responsible for the explosive vapor growth observed in Armstrong's experiment with LMFBR materials (liquid sodium injected into molten UO_2) is discussed. Basically, liquid sodium globules can be entrained and wet the liquid UO_2 surfaces. The lack of nucleation sites in the liquid–liquid-like system results in the overheating of the liquid sodium until homogeneous nucleation occurs. When the superheat limit is reached, vaporization is rapid enough to produce shock waves. The validity of the proposed entrainment-wetting-superheat mechanism to explain the observed UO_2–Na explosions has been demonstrated by above surface injection of liquid Freon-11 (normal boiling point 23.8°C) into hot water (70 to 90°C). This liquid–liquid system is believed to simulate Armstrong's UO_2– Na system, since in the latter, the transition from film boiling to nucleate boiling based upon Henry's film boiling correlation will take place at a temperature well above the melting temperature of UO_2. Based upon this mechanism, large-scale coherent UO_2–Na vapor explosions would appear impossible in a reactor environment. In a real reactor system, fission gases and fragments, as well as solid materials and gas bubbles entrained in the liquid sodium, would be present and would promote boiling prior to reaching the threshold for homogeneous nucleation in sodium, therefore resulting in mild interactions of the type observed in the TREAT in-pile experiments. (auth)

15961 INFLUENCE OF SOME INTERNAL FACTORS ON THE CORROSION OF STAINLESS STEELS IN AQUEOUS MEDIUM AT HIGH TEMPERATURES. Mindru, G.; Munteanu, A.; Popescu, E.; Vasiliu, F.; Zuda, A. Rev. Chim. (Bucharest); 24: No. 3, 195-200 (Mar 1973). (In Rumanian).

The problem of the corrosion of austenitic stainless steels in aqueous media at high temperature is discussed. The influence is examined of the thermic sensitizing treatment, of the carbon content in steel and of the surface preparation on corrosion. It was found that the thermic sensitizing treatment has no practical influence on general corrosion. The way of processing the surface markedly influences the corrosion behavior. The corrosion rate for the pickled and passivated tests was about half that for mechanically polished tests. It was also found that the corrosion speed increased with the carbon content. (23 figures). (auth)

15962 SOLID–GAS INTERACTIONS CASE OF ZIRCONIUM OXIDE UNDER REDUCED OXYGEN PRESSURE. Dechamps, M.; Lehr, P. (CNRS, Vitry-sur-Seine, France). pp 75-82 of Applications of Vacuum Sciences and Technology to Surface Coatings and Surface States. Paris; Societe Francaise des Ingenieurs et Techniciens du Vide (1972). (In French).

From 2nd international colloquium on the applications of vacuum sciences and technology to surface coatings and surface states; Lyon, France (19 Sep 1972).

The oxidation of zirconium under reduced oxygen pressure was studied. The experimental results were obtained using a thermobalance in the 600 to 1200°C temperature interval and the 10^{-2} to 10^{-5} torr oxygen pressure range. Successive kinetics corresponding to two stationary oxidation regimes were observed. During the initial period, the kinetics are linear; the second kinetics are parabolic and resemble those recorded under atmospheric pressure. (FR)

15963 STUDY OF SOLID–GAS INTERACTIONS. Oxidation of Zirconium, Titanium, and Titanium–Zirconium Alloys Under Reduced Oxygen Pressure. Dechamps, M. Metaux (Corros.-Ind.); 48: No. 569, 1-12(Jan 1973). (In French).

The results already available on the oxidation of zirconium and titanium are presented. The zirconium–oxygen, titanium–oxygen, zirconium–titanium, and titanium–zirconium–oxygen equilibrium diagrams are discussed. The techniques utilized in these investigations are described. (FR)

15964 HANDBOOK ON CORROSION TESTING AND EVALUATION. Symposium on the State of the Art in Corrosion Testing, Toronto, Canada, June 21–26, 1970. Ailor, W. H. (Ed.). Corrosion Monograph Series. New York; John Wiley and Sons, Inc. (1971). 884p. (CONF-700679--). $34.95.

The planning and preparation of corrosion tests is discussed, giving attention to metallurgical factors, statistical planning and analysis, and aspects of corrosion data reliability. Laboratory corrosion test methods are considered, including galvanic corrosion test methods, electrochemical methods, approaches to the study of stress-corrosion cracking, and liquid-metal test procedures. Atmospheric tests are reported together with seawater tests, testing in hydrospace and in fresh waters, tests in soils, and the testing of the corrosion resistance of coatings. Other subjects discussed are connected with the evaluation of corrosion effects. Thirty-three papers were presented at the symposium. A separate abstract was prepared for each of six papers selected for inclusion in NSA. (JRD)

For abstracts of individual papers see: 15965–15970.

15965 STATISTICAL DESIGN OF EXPERIMENTS. Makepeace, C. E. pp 59-85 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

It is noted that designed experiments may be used to obtain more information at less cost than those conducted in the Gaussian traditional method of experimentation. Fundamental concepts used in statistical design of experiments are described. Examples of designed experiments on the effects of U, Cu, and Cr on alloy steel sheet immersed in 10 wt % HCl solution and on corrosion of stainless steel in U recovery plant are given. (4 figures, 13 tables, 37 references) (LMT)

15966 TESTING NUCLEAR MATERIALS IN AQUEOUS ENVIRONMENTS. Barry, W. E. (Battelle-Columbus Labs., OH). pp 379-403 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

Procedures employed to evaluate the corrosion behavior of materials for reactor service are reviewed. Discussions and information are included on basic types of tests, special conditions and peculiarities of materials. A bibliography of testing and corrosion experiments is included. (9 figures, 69 references) (LMT)

15967 LIQUID-METAL TEST PROCEDURES. Klueh, R. L.; DeVan, J. H. (Oak Ridge National Lab., TN). pp 405-433 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

Test procedures for use with liquid alkali metals are reviewed. Discussions and information are included on mechanisms of liquid metal corrosion, test procedures, static isothermal capsules, refluxing capsules, tilting-furnace capsules, rotating cylinder test methods, autoclaves, thermal convection loops, and forced-convection loops. (16 figures, 62 references) (JRD)

15968 SENSITIZED COUPONS IN STEAM ACCEPTANCE TESTS. Goodwin, J. G. (Westinghouse Electric Corp., West Mifflin, PA); Gray, R. D.; Collins, L. F. pp 435-452 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

Methods of assessing the sensitivity of corrosion-testing facilities to the presence of unacceptable Zircaloy by the use of sensitized Zircaloy coupons are summarized. These coupons are heat treated in such a manner that their weight gain in 400°C 14-day steam corrosion acceptance tests is greater than that allowed for acceptable Zircaloy (38 mg/dm^2). These coupons are used along with standard test specimens of Zircaloy to provide assurance that the test is capable of detecting poor Zircaloy. (JRD)

15969 RADIOACTIVE TRACERS FOR INHIBITOR EVALUATION. Aladjem, A. (Soreq Nuclear Research Center, Yavne, Israel); Yahalom, J. pp 759-768 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

The application of tracer techniques in investigation of corrosion and inhibition phenomena is described. Two case histories to illustrate the methods are summarized. One of these histories is on the effect of sulfite ions on the corrosion of Ni alloys in seawater and brines and the other is on the effect of nitrate ions on the corrosion of Ta and Ta alloys in acid chloride solutions. (21 references) (JRD)

15970 ELLIPSOMETRY IN CORROSION TESTING. Kruger, J. (National Bureau of Standards, Washington, DC); Hayfield, P. C. S. pp 783-831 of Handbook on Corrosion Testing and Evaluation. Ailor, W. H. (ed.). New York; John Wiley and Sons, Inc. (1971).

From handbook on corrosion testing and evaluation conference; Toronto, Canada (21 Jun 1970). See CONF-700679-.

The optical theory behind ellipsometry is briefly developed, and the instrumentation and experimental aspects of the technique are described. Manual ellipsometers have been supplemented by a number of automatic instruments. For corrosion studies involving ellipsometry, an experimental cell is needed that contains the corrosion environment and the metal surface being studied while allowing the optical measurements to be made. Approaches for obtaining a bare substrate surface are discussed together with film thickness measurements, film growth and dissolution kinetics, problems of metal dissolution and surface roughening, film properties, and aspects of gaseous oxidation. Applications to corrosion engineering are also considered, giving attention to studies of copper, iron and stainless steel, aluminum, titanium, and beryllium. (19 figures, 109 references) (IAA)

15971 STRUCTURE OF SODIUM CORROSION DEPOSITS AND THEIR EFFECT ON HEAT TRANSFER COEFFICIENTS. Ray, W. E.; Miller, R. L.; Schrock, S. L.; Whitlow, G. A. (Westinghouse Nuclear Energy Systems, Madison, PA). Nucl. Technol.; 16: No. 1, 249-262(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Sodium mass transfer deposits up to 10 mils in thickness were observed on Type 304 stainless-steel, cold-leg surfaces after 10,000 h of steady-state operation. The magnitude of deposition was shown to be time- and location-dependent. Deposit thicknesses will continue to grow over the 40-y design life of the intermediate heat exchanger (IHX), with the only mechanisms which may tend to limit deposit thicknesses being flow shear forces at the wall, and stresses induced by thermal transients. Some of the physical and chemical properties of typical mass transfer deposits collected from primary and secondary sodium systems have been characterized. The composition was found to be highly dependent on the location in the system, and the first materials to precipitate were rich in chromium, whereas deposits located further downstream contained large amounts of manganese. A 50°F drop in temperature was normally sufficient to initiate precipitation of these deposits. Interpreted in terms of the reactor system, this would indicate that the step change in temperature, encountered when bypass streams are mixed with core coolant sodium, may be large enough to initiate deposition in the isothermal hot-leg piping. In addition to the metallic constituents, carbon concentrations as high as 2% were measured in the deposits together with significant quantities of nitrogen and oxygen. Since carbides, oxides, and nitrides typically exhibit lower thermal conductivities than metallic elements or alloys, it was expected that the deposits would represent a significant heat transfer resistance. Experiments were designed to measure the degradation in the heat transfer coefficient due to corrosion product deposition in small sodium loop systems. Application of these results to IHX and steam generator designs indicated a 9% reduction in heat transfer. (6 tables, 6 figures) (auth)

15972 SODIUM CORROSION AND MASS TRANSFER ANALYSIS WITH AN ION-PROBE MASS SPECTROMETER. Berkey, E.; Sweeney, G. G.; Hickam, W. M. (Westinghouse Research Labs., Pittsburgh). Nucl. Technol.; 16: No. 1, 263-277(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The initial application of ion probe mass spectrometry, a new analytical technique, to the characterization of samples from an experimental sodium mass transfer loop was made. The technique is capable of performing multielement analyses from hydrogen to uranium at parts per million sensitivities with a spatial resolution of ~1 μm. Analyses of hot-leg samples from a 10,000 h/low-oxygen loop reveal significant concentration changes over the depleted zone and confirm extensive loss of carbon. Analyses of cold leg deposits from the same loop show the presence of occluded metallic sodium and a small component of oxides, in addition to numerous other constituents. Concentration profiles in the deposits indicate that they are both nitrided and carburized with a major oxide layer in the interface between the deposits and the stainless-steel substrate. (14 figures, 18 references) (auth)

15973 INVESTIGATION OF THE OXIDATION KINETICS OF RHENIUM USING MOLECULAR-BEAM TECHNIQUES. Kaye, L. A. New Haven; Yale Univ. (1972). 139p. University Microfilms Order No. 73-14,565.

Thesis (Ph. D.).

The oxidation of rhenium was studied experimentally using constant flux and interrupted molecular beams of molecular oxygen. The reaction product flux of ReO_3 was measured for surface temperatures of 1350 to 2130°K and for oxygen fluxes of approximately 10^{16} molecules/cm²sec. The steady-state evaporation rate of ReO_3 was found to increase to a maximum and then decrease with increasing surface temperature. The effect of the beam properties on the evaporation rate was investigated by performing experiments with molecular beams of oxygen formed from room-temperature and heated nozzles, and with molecular beams of oxygen-helium mixtures and nitrous oxide. The nonsteady-state response of the system to a pulse of oxygen and to a square-wave-modulated oxygen beam was measured. A model is postulated to explain the experimental results. The parameters of the model were optimized with the steady-state data. The steps in the model include an immobile adsorption of oxygen as a "first" layer followed by adsorption of oxygen in a "second" layer. Surface diffusion of the oxygen adatoms in the second layer is postulated. Desorption of oxygen atoms from the first and second layer, and of ReO_2 and ReO_3, is also assumed. The model agrees fairly well with the observed experimental data and the data of other investigators. The fit was sufficiently good so that no optimization of the parameters of the model with the nonsteady-state data was necessary. (Diss. Abstr. Int., B)

15974 EVALUATION OF ELECTRODEPOSITED COATINGS. Part 1. Spencer, L. F. Metal Finish.; 70: No. 3, 38-41(Mar 1970).

The various techniques and equipment available for the measurement of coating thickness are surveyed with reference to experimental procedures, accuracy and scope of application. Methods covered include determination of the weight per unit area, calorimetric measurement of the heat of solution of the coating, coulometric analysis, direct measurement by micrometer caliper and by microscope, magnetic and eddy current probes, beta backscattering gauge, the drop test, and the jet test. Several of the methods described are applicable to zinc, cadmium or lead coatings on various substrate metals. (Corrosion Abstracts)

15975 CORROSION OF INCOLOY 800 AND NICKEL BASE ALLOY WELDMENTS IN STEAM. Hammond, J. P. (Oak Ridge National Lab., TN); Patriarca, P.; Slaughter, G. M.; Maxwell, W. A. Weld. J. (N.Y.); 52: No. 6, 268s-280s(Jun 1973).

The corrosion characteristics of similar and dissimilar metal weldments in Incoloy 800 and various nickel base alloys for use in advanced gas-cooled nuclear steam generators were tested in isothermal exposures in dynamic steam at 1100 and 1200°F at 900 psi pressure for periods to 16,000 h (2 years). Cursory examinations were made on some weldment specimens after exposure to 27,000 h. Twelve alloy combinations, in which base metals having good high temperature properties (Inconel 625, Hastelloy X, and IN 102) were joined to Incoloy 800 (a material having attractive intermediate temperature properties) and to themselves, were examined in the surface ground condition. Three high temperature alloys and Inconel 82 were employed as filler metals. To assess the effects of surface condition, the dissimilar metal weldments and non-welded specimens in the various base metals were also tested after being electropolished to eliminate worked surfaces. General corrosion was determined by weight gain, weight loss, and scale thickness measurements, and preferential attack in fusion line areas was assessed by metallographic means. Projected long time corrosion amounts were very small (<11 mg/cm² in 20 years) for all the weldments tested except those in Inconel 600, and for this weldment the projected corrosion was only 43 mg/cm² after 20 years. No evidence of aggravated attack at fusion line areas was disclosed. These findings appear to be applicable to weldments in the same alloys exposed to steam at lower temperatures. (auth)

15976 EXPERIMENTAL SETUP FOR STUDYING APPLICABILITY OF CARBON STEELS IN PRIMARY LOOPS OF AN ATOMIC POWER STATION WITH A WATER-MODERATED, WATER-COOLED POWER REACTOR. Margulova, T. Kh.; Voronova, V. P.; Dik, V. P. Tr. Mosk. Energ. Inst.; No. 126, 1-8(1972). (In Russian).

A semi-production installation simulating the conditions of the primary loop of an atomic power station with a water-moderated, water-cooled power reactor was developed and put into operation. The device can reproduce any water regimes and one can study the effect of individual water admixtures on the structural material and primarily on pearlite steel and zirconium alloys. Results of studies made on various experimental installations are given. (JPRS)

15977 ELECTROCHEMICAL MEASUREMENTS OF CORROSION PROCESSES IN A BOILING WATER NUCLEAR REACTOR. Cowan, R. L.; Kaznoff, A. I. (General Electric Co., Pleasanton, CA). AT(04-3)-189. Corrosion; 29: No. 4, 123-132(Apr 1973).

The results of an electrochemical investigation of the corrosion behavior of reactor structural materials determined both in and out of reactor are presented. Electrochemical kinetic measurements in and out of reactor were fairly difficult to obtain because of the high purity (and associated poor conductivity) of the electrolyte. Three methods were used to account for the high values of overpotential cause by IR effects. All three methods gave similar results. The kinetic data showed large regions of linear behavior (500 mV overpotential cathodic and 200 mV overpotential anodic) on the materials studied. No correlation was found between electrochemically calculated corrosion rates and descaled weight loss measurements on identical material. It was concluded that electrochemical reactions involving dissolved O_2 and H_2 were playing a dominant role and obscuring the contribution from metal oxidation. Selected potential measurements were made with a specially designed 0.01N Ag/AgCl electrode which allowed determination of electrode potentials on the standard hydrogen scale at 266 and 288°C. A system designed to allow electrochemically controlled sustained load stress corrosion tests in high temperature electrolytes is described. The results from these tests agree with results from more conventional tests. (auth)

15978 INFLUENCE OF COLD WORK ON THE STRESS CORROSION SUSCEPTIBILITY OF Ti-13V-11Cr-3Al. Munford, J. W.; Rack, H. J. (Sandia Labs., Albuquerque, NM). Corrosion; 29: No. 4, 146-147(Apr 1973).

Experimental results show that thermomechanical processing markedly reduced the stress corrosion susceptibility of Ti-13V-11Cr-3Al, at least for smooth specimens in neutral aqueous solutions. A number of factors appear to contribute to this behavior. Heavily dislocated cell structure results in an effective decrease in the grain size, and the avoidance of planar slip deformation. Experimental results also show that decreasing the grain size in Ti-13V-11Cr-3Al and promoting turbulent slip by increasing the available mobile dislocation density, reduces the susceptibility to stress corrosion cracking. Another factor which should contribute to the reduced susceptibility is the ⟨110⟩ wire texture introduced by thermomechanical processing procedure. This texture will increase the critical stress necessary to initiate a (100) microcrack over that which would have been observed in a random microstructure. (JRD)

15979 STRESS CORROSION CRACKING OF AGED U-4.5 WT. % Nb. Macki, J. M.; Kochen, R. L. (Dow Chemical Co., Golden, CO). Contract AT(29-1)-1106. Corrosion; 29: No. 4, 153-156(Apr 1973).

The stress corrosion cracking (SCC) behavior of the U-4.5 wt % Nb alloy aged 80 hours at 260°C has been investigated. Smooth four point bend SCC tests and smooth static tensile SCC tests were used. The results of this study show that aged U-4.5 wt % Nb alloy is susceptible to SCC when stressed and exposed to water containing oxygen and chloride ions. The stress corrosion cracks which nucleate in the aqueous chloride environments proceed by an intergranular SCC fracture mode. No failures were observed in dry air containing less than 200 ppM moisture or in 100% relative humidity air. The surface tensile stress required for SCC is less than 20,000 psi in oxygen saturated water containing 50 ppM chloride ions. (auth)

15980 FLUORIDE SALT CORROSION AND MASS TRANSFER IN HIGH TEMPERATURE DYNAMIC SYSTEMS. Koger, J. W. (Oak Ridge National Lab., TN). Corrosion; 29: No. 3, 115-122(Mar 1973).

Corrosion tests ranging from 3000 to 20,000 hours were conducted on nickel and iron based alloys in fused fluoride salt at temperatures ranging from 450 to 704°C. The objective of the experiment was to find suitable fused salt container material for application in the nuclear molten salt reactor. The materials tested were Hastelloy N, titanium modified Hastelloy N, Type

304L stainless steel, and a maraging steel. The two types of salts were (1) $LiF-BeF_2$ with varying amounts of UF_4, ThF_4, and ZrF_4, (fuel salt), and (2) a mixture of $NaBF_4$ and NaF (coolant salt). The compatibilities of these materials with the salts were determined from weight change data and chemical, metallographic, and electron microprobe analyses of the test specimens along with chemical analyses of the salts. The corrosion was manifested as temperature gradient mass transfer. The rate of corrosion of Hastelloy N in $LiF-BeF_2$ base salts was controlled by diffusion of chromium in the alloy and was very small (<0.1 mpy at 704°C), but the attack of stainless steel by the fuel salt was larger (1.1 mpy at 688°C). Hastelloy N in $NaBF_4-NaF$ showed a uniform attack (0.6 mpy at 607°C) controlled by impurity reactions. A titanium modified Hastelloy N with no iron showed smaller weight changes than standard Hastelloy N with 5% Fe under similar conditions in a fuel salt. A maraging steel with less chromium than stainless steel had a corrosion rate half that of the stainless steel under similar conditions in a fuel salt. (auth)

15981 EFFECT OF EXPOSED NONMETALLIC INCLUSIONS ON CORROSION RESISTANCE OF TYPE 304 STAINLESS STEEL IN A SIMULATED PRESSURIZED WATER REACTOR ENVIRONMENT. Lyle, F. F. Jr. (Southwest Research Inst., San Antonio, TX). Corrosion; 29: No. 3, 86-94(Mar 1973).

Tests conducted on samples of Type 304 tubing are described. The major objective of the tests was to determine if exposed nonmetallic inclusions in the tubing would have a detrimental effect on the corrosion resistance of the material in the N. S. Savannah's pressurized water reactor environment. Inclusions were located by ultrasonic techniques and were exposed by metallographic methods. Two general types of inclusions were present: (1) stringers, consisting of complex Mn–Fe–Cr oxides ranging in length from 0.005 to 0.050 inch, and (2) blocks, consisting of complex Mn–Fe–Cr silicates with a maximum length of 0.010 inch. Inclusion thickness varied from less than 0.001 inch for stringers to about 0.002 inch for the block type; maximum width of both types was approximately 0.004 inch. Tests were conducted in a 5 gallon autoclave made of Type 316 stainless steel. Test solutions consisted of deoxygenated, deionized water which met N. S. Savannah primary coolant water specifications. Water temperature was maintained at 332°C which was the cladding surface temperature during reactor operation. System pressure was maintained above the saturation pressure of water at 332°C by applying an overpressure with a mixture of argon and hydrogen; nominal working pressure throughout the tests was 2,000 psig. Specimens containing exposed inclusions were evaluated metallographically after one, two, and three months of exposure; both solution annealed and furnace sensitized material were tested. No accelerated or preferential corrosion of the metal surrounding the inclusions or dissolution of the inclusions occurred. The only corrosion detectable was a light, general etching of the surface resulting in the formation of an adherent film of magnetite. There was no observable difference in corrosion resistance of solution annealed and sensitized metal. (auth)

15982 EFFECT OF HIGH DISLOCATION DENSITY ON STRESS CORROSION CRACKING AND HYDROGEN EMBRITTLEMENT OF TYPE 304L STAINLESS STEEL. Louthan, M. R. Jr.; Donovan, J. A.; Rawl, D. E. Jr. (Savannah River Lab., Aiken, SC). Corrosion; 29: No. 3, 108-111(Mar 1973).

Thermomechanical treatment to inhibit the formation of martensite and increase the resistance of Type 304L stainless steel to stress corrosion and hydrogen embrittlement is described. Specimens of Type 304L steel subjected to high energy rate forging and annealing were tested in tension after exposure to hydrogen at 10,000 psi. Results show that thermomechanical treatments increase the resistance to stress corrosion cracking and hydrogen embrittlement in this steel. (JRD)

15983 CRACKING OF Ti–6Al–4V IN METHANOL SOLUTIONS CONTAINING SULFATES. Haney, E. G.; Fugassi, P. (Carnegie-Mellon Univ., Pittsburgh). Corrosion; 29: No. 3, 112-114(Mar 1973).

Whether cracking of unnotched Ti–6Al–4V specimens occurs in methanol solutions containing H_2SO_4, Li_2SO_4, or $Fe_2(SO_4)_3$ is a function of the age of the solution and the concentration of the sulfate. With H_2SO_4 concentrations of 0.10 to 0.25N the methanol solutions lose their ability to crack the specimens with time after mixing and prior to exposure. The aging time required to inhibit the cracking varies inversely with the water content of the solution. With larger quantities of 0.5 and 1N H_2SO_4 no cracking is observed. Interpretations of Raman spectroscopic studies of the aging solution suggests that the nature of the O-H group may play a role in the crack initiation or inhibiting mechanism. (auth)

Preparation and Fabrication

Refer also to abstracts 15874, 15894, 15920, 17711, 17712, 17783, 17801, 17806, and 17812.

15984 (AI-AEC–13082) PROCESS DEVELOPMENT AND FABRICATION OF ZIRCONIUM HYDRIDE HASTELLOY X CLAD FUEL ELEMENTS. Parker, T. G. Jr. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT (04-3)-701. 44p. Dep. NTIS $4.25.

A summary is presented of the development work performed, and the processes established, for the fabrication of Hastelloy X-clad, $U-ZrH_x$ fuel elements. Processes described include: U–Zr alloy melting and extrusion, U–Zr hydriding, Gd_2O_3 vapor deposition of $U-ZrH_x$ fuel rods, machining helical fins in Hastelloy X cladding, Hastelloy X electron beam welding, ceramic coating of Hastelloy X, and final assembly operations. Process and test data on developmental fuel elements are presented, which demonstrate that the dimensional and performance test requirements of the 5-kW(e) zirconium hydride reactor could be met. (auth)

15985 (LA-5255-MS) INITIAL DEVELOPMENT AND CHARACTERIZATION OF PLUTONIA–IRIDIUM CERMETS (PIC). Tokar, M.; Shupe, M. W.; Kent, R. A.; Zocher, R. W.; Keenan, T. K. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 23p. Dep. NTIS $4.00.

An investigation of a plutonia–iridium cermet (PIC) as a candidate radioisotopic fuel was initiated. Specimens containing 11 to 15 vol % iridium as a continuous phase were prepared by a multi-step process that includes: (1) granulation and prefiring of $^{238}Pu^{16}O_2$ to provide a ceramic phase having a selected size distribution usually ranging from 61 to 297μ, (2) comminution of -325 mesh Ir powder to $\leq 5\mu$ particles, (3) coating or mixing the ceramic granules with the metallic particles, (4) hot pressing the mixture in vacuum, and (5) adjustment of the stoichiometry of the oxide by heat treatment in a suitable atmosphere. The resultant microstructures consist of islands of $^{238}Pu^{16}O_2$ surrounded by a continuous Ir coating approximately 2 to 5μ thick. Several small pellets, nominally 0.3 in. diameter, have been prepared as well as a 1.5 in. diameter sphere with a ^{238}Pu thermal inventory of 100 watts. The pellets were used for process development, fractography, chemical analyses, metallography, and strength measurements. The sphere was fabricated to verify process upscaling from the pellet development. It was subjected to thermal testing. (auth)

15986 (ZJE-122) WELDING OF THICK-WALLED PRESSURE VESSELS OF NUCLEAR AND CHEMICAL REACTORS. Becka, J.; Konigsmark, J.; Kricka, P.; Vlcek, V. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1972. 34p. Dep. NTIS (U. S. Sales Only) $3.75.

Data are given concerning welding of the nuclear reactor cylindrical pressure vessel weighing 725 tons made from low-alloyed C–Mn–Ni steel and both spherical and cylindrical pressure vessels for the chemical reactors weighing 110 tons made from 2.25% Cr–1% Mo steel. (auth)

15987 EFFECT OF NICKEL SOLID-PHASE COATING ON KINETICS OF TUNGSTEN WIRE SINTERING. Geguzin, Ya. E.; Klinchuk, Yu. I.; Paritskaya, L. N. (Kharkov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 30-34(May 1973). (In Russian).

A possible mechanism is discussed for the activating effect of a solid-phase coating on shrinkage kinetics during sintering. The mechanism suggested is connected with the appearance discrepancy dislocations on the coating-powder particle interface. Expediency of the suggested mechanism is substantiated by model experiments carried out on tungsten wires covered with a nickel layer. (auth)

15988 METHOD OF REFINING PRIMARY CRYSTALS OF INTERMETALLIC COMPOUNDS IN Al ALLOY CASTINGS. Dobatkin, V. I.; Malinovskii, R. R. pp 82-88 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The nature of the primary crystallization of intermetallic compounds is studied as a function of the high-melting metal concentration in the alloy and the casting temperature. The dependence of the motion of the crystallizing alloy on technological additions and on precooling of the melt supplied to the crystallizer is also studied. In view of the stability of intermetallic crystals at room and elevated temperatures, it is proposed to use primary crystallization of intermetallic compounds for obtaining composite hardfacing rods. Alloys studied included Al–0.9% Zr and Al–1% Mo. (IAA)

15989 HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT OF DEFORMABLE Mg–Nd ALLOYS. Drits,

M. E.; Sviderskaya, Z. A.; Oreshkina, A. A. pp 127-136 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The influence of combined heat treatment and machining on the structure and mechanical properties of MA11 (2.5 to 3.5% Nd, 1.5 to 2.5% Mn, 0.13 to 0.25% Ni, rest Mg) and MA12 (2.0 to 4.0% Nd, 0.4 to 0.9% Zr, rest Mg) alloys is investigated. Study of the mechanical properties at 20, 250, and 300°C showed that for 87% strain, the optimum treatment for MA11 is heating of the bars at 490°C for 2 h, cooling in air to 325–420°C, and pressing at these temperatures into 10.5-mm rods. For MA12, the optimum treatment is heating 530°C for 2 h, and cooling in air to 270–375°C. Analysis of the structural changes showed that the observed strain-hardening should be attributed to distortions of the crystal lattice of magnesium-rich solid solution and to changes in the kinetics of the relaxation, recrystallization, and decomposition of supersaturated solid solution. (IAA)

15990 PREPARATION OF Nb GERMANIDES BY COREDUCTION OF THE HIGHER CHLORIDES BY HYDROGEN. Valueva, N. A.; Petrusevich, I. V.; Nisel'son, L. A. (State Scientific Research and Design Inst. of the Rare-Metal Industry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 12, 1831-1835(Dec 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 12, 2083-2088(Dec 1972).

It is shown that compounds may be obtained in the system Nb–Ge by coreduction of their chlorides by hydrogen. Conditions for obtaining one-phase Nb_3Ge with $T_s = 17.5–19°K$ were determined. (6 figures) (auth)

15991 PROCESS FOR JOINING A NIOBIUM TUBE TO A STAINLESS STEEL TUBE. Dufrene, J.; Lacoste, J.; Schley, R.; Tortel, J. (to Commissariat a l'Energie Atomique). French Patent 2,129,255. 27 Oct 1972. Filed date 19 Mar 1971. 5p. (In French).

A process for joining a niobium tube to a stainless steel tube is presented. The niobium tube is loosely fitted into the stainless steel tube which is provided at its end with an external machined collar which serves as a reservoir. This reservoir is filled with an appropriate brazing material. The system is placed in a secondary vacuum and brought to a temperature between 1020 and 1030°C. After brazing, the reservoir is eliminated. The stainless steel used contains 18% nickel and 8% chromium. The braze consists of 10% phosphorus, 13% chromium and 77% nickel. (FR)

15992 ELECTROLESS PLATING AND COATING OF METALS, 1972. McDermott, J. Noyes Data Books On Coatings and Paints. Park Ridge, NJ; Noyes Data Corporation (1972). 310p. $36.00.

Descriptive information relating to electroless plating and coating of metals is presented. The information is based on U. S. Patents dated 1967 or later. Sections are included on Cu; Ni, Cr, Co; Al, Zn, Sn; precious metals; refractory metals; and high performance alloys. (JRD)

15993 PRESENT STATUS OF POWDER METALLURGY IN WEST GERMANY. Zapf, G. (Sintermetallwerk, Krebsoege, Ger.). Int. J. Powder Met.; 9: No. 3, 127-140(Jul 1973).

Activities in the powder metallurgy industry are reviewed. Information and discussions are included on W and Mo powder metallurgy products, hard metals, electric contacts, sintered magnets, porous sintered materials, powder metallurgy parts, equipment for fabrication, raw materials, research organizations, and research programs. (JRD)

15994 EFFECTS OF ELECTRODE COVERINGS ON ELEVATED TEMPERATURE PROPERTIES OF AUSTENITIC STAINLESS STEEL WELD METAL. Binkley, N. C.; Goodwin, G. M.; Harman, D. G. (Oak Ridge National Lab., TN). Weld. J. (N.Y.); 52: No. 7, 306s-311s(Jul 1973).

The creep-rupture properties at 1200°F of deposits made with the flux-covered E308 electrode depend on the type of covering used. Batches of electrodes with lime, lime-titania (about 25% TiO_2), and titania (about 50% TiO_2) flux coverings were produced from a single heat of Type 308 stainless steel core wire by a commercial producer. The covering formulas were adjusted to produce weld deposits of essentially identical composition. One-inch thick, Type 304 stainless steel plates were joined with each batch under identical conditions of current, voltage and travel speed. The three different weld deposits exhibited essentially identical deposit composition, ferrite number, and ferrite morphology. However, the three weldments had significantly different creep-rupture characteristics at 1200°F. The lime-covered electrode deposit exhibited comparatively short rupture times and high ductility. The lime-titania and the titania-covered electrode deposits had significantly longer rupture times at a given stress level, but strained less than 1% before failing at rupture times approaching 1000 h. The lime-covered electrode deposit also demonstrated low fracture ductility at low stresses when tested to rupture. (auth)

15995 WELDING OF LARGE ALUMINIUM VESSELS. Hauner, M.; Machnik, V. Skoda Rev.; No. 1, 17-23(1973).

Methods for welding Al and Al alloy pressure vessels are described. Information and discussions are included on Al weldability, welding of the KS 150 reactor pressure vessel, and inspection of welded joints. (JRD)

15996 BIMETALS. Sadaj, J. Rudy Metale Niezelaz.; 18: No. 1, 27-30(1973). (In Polish).

Various types of bimetallic combinations of specific properties are discussed, and the technique of bimetal production is described. Particular attention is drawn to the structural and phase effects taking place in the transient zone which have an important influence on bimetal properties. (auth)

15997 CONTAMINATION BY CARBON IN FURNACES WITH GRAPHITE COMPONENTS. Dubois, J.; Jeanjean, R.; Riviere, R. (Institut National des Sciences Appliquees, Villeurbanne, France). Vide; No. 162, 260-263(1972). (In French).

The problem of pollution by carbon, between 800 and 2300°C in graphite–component furnaces is discussed. The process of contamination which differs according to the temperature is first discussed: at low temperature the transfer is carried out by carbon monoxide; at high temperature by the vapor stage. Then, by way of experiment, the importance of pollution on tantalum samples was evaluated and attempts were made to eliminate this pollution. The injection of a neutral gas, as it reduces the speed of sublimation, limits contamination but does not entirely prevent it; but placing a "mask" around the sample allows thermal treatment in vacuum without pollution by carbon. (auth)

15998 ECONOMIC ASSESSMENT OF VANADIUM REDUCTION FROM VANADIUM PENTOXIDE USING PLASMA. Morel, S. Rudy Metale Niezelaz.; 18: No. 1, 25-27(1973). (In Polish).

The basic properties and uses of vanadium are discussed. The occurrences of vanadium and classical methods of vanadium extraction are described. The main principles of vanadium reduction from pure vanadium pentoxide in a plasma furnace are outlined. The costs of raw material, reductor and plasma production per 1 kg of reduced vanadium are given. It was established that raw material and processing costs represent about 1% of the price of pure vanadium. (auth)

15999 POLAND'S ZIRCONIUM REQUIREMENTS. Rutkowski, W. Rudy Metale Niezelaz.; 18: No. 1, 23-24(1973). (In Polish).

A brief description is given of the uses of zirconium and its alloys as a shielding and structural material in nuclear power reactors, and the Polish zirconium requirements to cover the planned development of domestic nuclear power are estimated. Some other industrial applications of zirconium and its alloys and compounds are also mentioned. Data presented suggest the advisability of initiating zirconium production in Poland. (auth)

16000 DEVELOPMENT OF A TECHNOLOGICAL PROCESS FOR PRODUCTION OF RHENIUM COATINGS BY THE CARBONYL METHOD. Syrkin, V. G.; Uel'skii, A. A.; Akmeeva, R. I.; Romanova, L. N. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 10, 2366-2369(Oct 1972).

Translated from Zh. Prikl. Khim.; 45: No. 10, 2261-2264(Oct 1972).

Research on processes for the production of hard rhenium coatings are described. Results show that the rate of deposition of rhenium coatings increases with increase of the temperature of the coated specimens to 500°C. Further increase of temperature leads to a fall of the deposition rate. The character of the dependence of the rate of deposition of rhenium coatings on the temperature of the carbonyl is close to exponential. The microhardness of rhenium coatings depends on the deposition temperature. Coatings formed at 400°C are the hardest (≥800 kg/mm²). The microhardness decreases with further increase of temperature, and at 1000°C it is 270 kg/mm², which corresponds to the microhardness of the pure metal. The external surface of coatings deposited on specimens at 400°C at various carbonyl temperatures consists of individual droplike spheres; their size increases at first with the temperature of the support, but subsequently they disintegrate and form individual crystals. Coatings formed at a specimen temperature of 400°C have a stratified appearance. Coatings having a columnar structure are deposited at higher temperatures. (auth)

16001 A NEW TECHNIQUE FOR HIGH SPEED ANODIZATION IN A DC OXYGEN GLOW DISCHARGE. O'Hanlon, J. F.; Sampogna, M. (IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598). J. Vac. Sci. Technol. 10: No. 3, 450-452 (May 1973).

In this paper a new technique for high speed anodization in a dc oxygen discharge is reported. A 0.0025-cm-diam wire biased 50 V positive with respect to the anode caused a ten- to fifteenfold increase in the anodization rate. Rates as high as 30 Å/min were observed with a sample current denisty of 1.15 mA/cm^2. With a current density of 0.21 mA/cm^2 the Faraday efficiency was 15%. It is postulated here that the observed effects are due to increased surface ionization of adsorbed atomic oxygen. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 15845, 15860, 15881, 15904, 16828, 17001, 17421, 17430, 17432, 17459, 17484, 17723, 17730, 17731, 17743, 17758, 17763, 17765, 17766, 17778, 17779, 17790–17793, and 17802.

16002 (CEA-CONF-2187) HIGH-TEMPERATURE RUPTURE. Sainfort, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 17 Jan 1973. 48p. (In French). (CONF-721221-2). Dep. NTIS (U. S. Sales Only) $4.50.

From conference on studies on the flow and relaxation of steels; Lyon, France (5 Dec 1972).

The following points are discussed: empirical laws concerning the rupture time; metallographic observations; mechanisms associated with the germination and growth of intergranular cavities; effect of various parameters (temperature, amplitude and direction of the stress, hydrostatic pressure, composition and purity of the alloys, inter- and intragranular precipitation, environment and irradiation). (54 references) (FR)

16003 (COO-3158-22) THEORY OF DIFFUSE X-RAY SCATTERING BY INTERSTITIALS IN BCC METALS. Benedek, R.; Ho, P. S. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jun 1973. Contract AT(11-1)-3158. 16p. Dep. NTIS $3.00.

Starting with a Green's function lattice statics approach, an expression is derived for the diffuse x-ray scattering cross section of interstitials in cubic metals. Numerical calculations were performed, based on interatomic potentials for tungsten, for the six possible geometrical configurations of an intrinsic interstitial in a bcc metal. The relevance of such calculations to the problem of determining the stable form of the interstitial is discussed. (auth)

16004 (EUR-5017) PREDICTION OF CRITICAL CONDITIONS FOR FAILURE IN Zr–2.5% Nb PRESSURE TUBES BY THE C. O. D. CRITERION. Henry, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jun 1973. 31p. (In French). Dep. NTIS (U. S. Sales Only) $3.75. EUR FB 50,-.

C. O. D. (Crack Opening Displacement) measurements made during pressurization to failure of longitudinally cracked ID 92 mm, 2.7- to 3-mm-thick tube sections in Zr–2.5% Nb alloy allowed one to check the "Strip yield model" based correlation proposed by Burdekin and Stone: $\delta = 8\sigma_y a/\pi E \text{ Log } [\sec(\pi\sigma/2\sigma_y)]$ corrected by the Folias factor for the bending effects on the crack flanks. Moreover, the critical conditions for failure of the tube sections [critical C. O. D. and tangential stress] were compared to those predicted by the combination of the above correlation and the critical C. O. D. values measured on small S. E. N. specimens. The same check was done on hydrided specimens and one hydrided tube section. Even though the analysis of the results is complicated by a notable scattering which seems connected to the material behavior itself, it is concluded that the critical crack length of these pressure tubes may be predicted with a precision of about 30% on the basis of the C. O. D. sub-scale test, sufficient to a correct application of the leak-before-break criterion. (auth)

16005 (ORNL-tr-2459) METASTABLE PHASES IN URANIUM–TITANIUM ALLOYS. Anagnostidis, M.; Baschwitz, R.; Colombie, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.) from Mem. Sci. Rev. Met.; 63: No. 2, 163-168(1966). 15p. (CONF-641032–1). Dep. NTIS $3.00.

From autumn sessions of the French Society of Metallurgy; Paris, France (Oct 1964).

The U–Mo, U– Nb, and U–Ti alloys seem to have in common the nature and process of formation of the metastable phases α', α'_a, α'_b, and α''_b. On the contrary, the U–Ti system differs from the U–Mo and U–Nb systems essentially by the following points: (1) existence of a biphase region $\alpha''_b + \gamma^0$; (2) the variation of the parameter b does not follow the law of Végard; and (3) the boundaries of the different phases do not correspond to the same contractions of the parameter b as in the U–Mo and U–Nb systems. Titanium would therefore have a behavior different from those of molybdenum and niobium. This could be due to the relative position of these elements in the periodic classification or to different bonds between uranium and titanium. (12 figures, 16 references) (auth)

16006 (ORO-4212-15) QUANTITATIVE DETERMINATION OF THE STRUCTURE–PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Quarterly Progress Report, January 1–March 31, 1973. Rhines, F. N.; DeHoff, R. T.; Whitney, E. D. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Jun 1973. Contract AT(40-1)-4212. 36p. Dep. NTIS $4.00.

A new, promising procedure for producing controlled microstructural gradients in porous bodies was tested. Gas permeability data for both UO_2 and nickel sinterings appear to be related to microstructure by analogous but not identical equations. A re-analysis of all of permeability data was undertaken with an alternate description of the process; the effect of this analysis upon the permeability parameters, and their correlation with microstructure, will be presented in the next annual report. Expansion of the studies of creep in porous nickel to cover a range of particle sizes uncovered a synergistic effect between creep and densification. This behavior is deduced from the observation that the creep rate increases with decreasing particle size, at temperatures where no significant sintering is expected. A rationale explaining the observed effect of compaction pressure upon tensile strength of sintered UO_2 samples, tracing the effect to microstructural differences, was developed. The use of the vacuum hot press, with a suitable hydraulic attachment, for producing and measuring creep of porous UO_2 samples at high temperatures, was shown to be feasible. (auth)

16007 (UCID-16253) PROPOSED MODEL RELATING STRESS, STRAIN, STRAIN RATE, AND STRAIN ENERGY. Lord, D. E. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Apr 1973. Contract W-7405-Eng-48. 39p. Dep. NTIS $4.00.

The study of high rate behavior of materials from an energy standpoint has led to a workable model relating stress, strain, strain rate, and strain energy. The original study encompassed extremes in strain rates, from very high to very low. Three separate sources—radiation deposition, gas-driven rams or projectiles, and conventional testing machines—were used. Data from the three sources was correlated and the behavior of selected materials ranging from brittle to very ductile suggested the model. The model was then verified by testing additional materials at various strain rates. (auth)

16008 (UCID-16254) MODEL RELATING STRESS, STRAIN, STRAIN RATE, AND TEMPERATURE WITH AN EXPERIMENTAL DATA FIT FOR A URANIUM–7.5% NIOBIUM–2.5% ZIRCONIUM ALLOY. Lord, D. E. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Apr 1973. Contract W-7405-Eng-48. 18p. Dep. NTIS $3.00.

Theoretical results obtained with a model developed as a result of a strain energy-to-failure investigation agreed well with experimental results from a previous extensive strain-rate and temperature-excursion investigation of properties of γ uranium–7.5% niobium–2.5% zirconium alloy. A relationship was established between strain rate and temperature over rather wide ranges, including a phase change, for this alloy, and a softening-point correlation for it was also established. The model seems to be readily extrapolative to other materials. (auth)

16009 (UCLA-34-P-177-12) REACTOR STEELS STUDIES. Quarterly Progress Report, January–March 1972. Ardell, A. J.; Ono, K.; Tetelman, A. S. (California Univ., Los Angeles. Dept. of Materials). Jul 1972. Contract AT(04-3)-34. 25p. Dep. NTIS $3.25.

Results of biaxial stress–rupture testing at 1000, 1200, and 1400°F are given for Type 316 stainless steel tubing containing 0 to 20% cold working. Cold work appears to increase the stress–rupture lifetime of Type 316 stainless steel, and the resulting microstructures are discussed. (DLC)

16010 (UCLA-34-P-177-13) REACTOR STEELS STUDIES. Quarterly Progress Report, April–June 1972. Ono, K.; Tetelman, A. S.; Ardell, A. J. (California Univ., Los Angeles. Dept. of Materials). Sep 1972. Contract AT(04-3)-34. 13p. Dep. NTIS $3.00.

Yield and ultimate tensile strengths were measured as a function of tempering at 950 and 1050°F for 2¼ Cr–1 Mo steels containing 0.01, 0.03, and 0.10% C. Effects of tempering at 1300°F are also considered, and the resulting microstructures are discussed. Time-to-rupture vs hoop stress data are given for 20% cold worked Type 316 stainless steel prototype FTR cladding at 1400°F. The equipment for stress-rupture testing is described. (DLC)

16011 (UCRL-Trans-10698) CREEP RESISTANCE AND CYCLIC HEATING STABILITY IN THE α-REGION OF BINARY

ALLOYS OF URANIUM WITH TITANIUM, VANADIUM, AND CHROMIUM. Sladkova, N. E.; Grigorovich, V. K. 1963. Translated from pp 162-168 of Stroenie i Svoistva Splavov Urana, Toriya i Tsirkoniya, Moscow, 1963. 9p. Dep. NTIS $3.00.

Effects of cyclic heating on the dimensional and structural stability of α-phase binary uranium alloys with Cr, Ti, and V were studied. The results of chemical analyses of U–Ti and U–V alloys were tabulated. The alloy of uranium with chromium in the range 0.1 to 4 at. % is accompanied by an improvement in the surface and a decrease in the elongation of the specimens after thermal cycling. Creep-rate diagrams were constructed for alloys with titanium and vanadium. Relative increases in diameters are shown in alloys of uranium with Cr, Ti, and V after cyclic heatings (500 to 2000 cycles: 600 ⇌ 35°C). Relative increases in diameters and residual deformation are shown in alloys of uranium with Cr, Ti, and V after thermal cycling 35 ⇌ 600°C and 500 to 2000 cycles. Impact strength of U–Ti and U–V was studied after thermal-cyclic treatments (1000 cycles at 600 ⇌ 35°C). (MCW)

16012 (UJV-2948-M) TABLES FOR THE INTERPRETATION OF SPOT DIFFRACTION PATTERNS OF α-ZIRCONIUM. Kocik, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1973. 16p. (In Czech). Dep. NTIS (U. S. Sales Only) $3.00.

Tables are given for quick and correct interpretation of spot diffraction patterns of α-zirconium corresponding to 106 most densely occupied reciprocal lattice planes. The tables give the indices (hkil) of at least three diffracting planes, their common zone axis [uvtw], the values of corresponding interplanar spacing ratios, and chosen interplanar angles. The method is based on the measurement of lengths of noncollinear vectors $\vec{R}$(hkil) of the diffraction pattern and the comparison of their length ratios with values of interplanar spacings ratios in the tables. Results of the paper by Komrska and Peňáz (Acta Sc. Nat. Brno, 4: No. 3, 1-40 (1979)) valid for hcp structures with ideal c/a ratio were recalculated for crystallographic parameters of α-zirconium. The four-index Miller–Bravais crystallographic notation was used. (auth)

16013 (WARD-NA-3045-2) EFFECT OF CARBON AND NITROGEN ON THE SHORT-TERM TENSILE BEHAVIOR OF SOLUTION-TREATED TYPES 304 AND 316 STAINLESS STEELS. Soo, P.; Horton, W. H. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1973. Contract AT(11-1)-3045. 48p. AT.

An analysis has been conducted to determine the effects of interstitial carbon and nitrogen on the short-term tensile behavior of solution-treated Types 304 and 316 stainless steel. At constant test temperature, it is shown that the yield strength, ultimate tensile strength, and total elongation are proportional to the combined carbon and nitrogen concentration, for carbon and nitrogen levels below about 0.13 weight percent. Statistical design equations have been evaluated for these materials that give the tensile properties as a function of test temperature and total interstitial level. (auth)

16014 TRANSFERRED MAGNETICALLY INDUCED Al^{27} QUADRUPOLE INTERACTION IN $GdAl_2$. Degani, J.; Kaplan, N. (The Racah Institute of Physics, The Hebrew University, Jerusalem, Israel). Phys. Rev. B 7: No. 5, 2132-2135 (1 Mar 1973).

A direct observation of a magnetically induced electric field gradient (efg) at a non-magnetic Al site in ferromagnetic $GdAl_2$ is described. The efg was determined from accurate measurements of the Al^{27} nuclear spin-echo envelope-modulation frequency, performed on Al in a sites for which the magnetization $\vec{M}$ and the crystaline efg axis are colinear. Monitored as function of M, it is found that the total efg in a sites is given by $q = q_c - M/M_{sat} q_m$, with $e^2Q^{27}q_c = 4.19 \pm 0.05$ MHz and $e^2Q^{27}q_m = 0.577 \pm 0.05$ MHz. The origin of q_m, is as yet unclear, since simple models leading to induced efg will result in M^2 dependence for the transferred-induced efg term, contrary to the linear M dependence presently observed. (auth)

16015 POLARIZED-NEUTRON STUDY OF THE INDUCED MAGNETIC MOMENT IN TMSB. Lander, G. H.; Brun, T. O. (Argonne National Laboratory, Argonne, Illinois 60439); Vogt, Oscar. Phys. Rev. B 7: No. 5, 1988-2004 (1 Mar 1973).

The magnetic form factor of the induced moment in TmSb has been measured with polarized neutrons. Thulium antimonide is a singlet-ground-state system, i.e., it has no spontaneous magnetic moment, but under the conditions of the experiment the magnetization develops through the mixing of the ground state with the first excited state. The experiments were performed on a single crystal at 5 °K and an applied field of 12.5 kOe. Measurements were taken with $\vec{H} \| \langle 100 \rangle$ and $\vec{H} \| \langle 110 \rangle$. The theoretical magnetic form factor has been derived using the tensor-operator technique of Johnston, Lovesey, and Rimmer, and the nonrelativistic wave functions of Freeman and Watson. The experimental form factor with $\vec{H} \| \langle 100 \rangle$ is essentially a smooth curve as a function of $\sin\theta/\lambda$, while for $\vec{H} \| \langle 110 \rangle$ considerable anisotropy is observed at high scattering angles. This anisotropy arises from the nature of the ground state and is determined by the crystal field acting on the rare-earth ion. The present technique may therefore be useful in investigating the ground states of the many compounds with unquenched orbital moments and appreciable crystal field interactions. The experimentally observed anisotropy is in complete agreement with theory. Previous polarized-neutron experiments on rare-earth metals indicate that the spatial extent of the 4f electrons is more expanded than given by the nonrelativistic calculations. The observed form factor in TmSb does not agree with the form factor calculated with nonrelativistic wave functions. Good agreement is obtained by using the 4f radial distribution as determined from polarized-neutron measurements on thulium metal. A set of $\langle r^n \rangle$ integrals has been derived from the experimental radial densities. (auth)

16016 EFFECT OF HYDROSTATIC PRESSURE ON THE ELASTIC AND INELASTIC BEHAVIOR OF GADOLINIUM IN THE SPIN-REORIENTATION REGION. Klimker, H.; Rosen, M. (Nuclear Research Centre, Negev, Beer-Sheva, Israel). Phys. Rev. B 7: No. 5, 2054-2061 (1 Mar 1973).

The effect of hydrostatic pressures, up to 6 kbar, on the anomalies occurring in the ultrasonic wave propagation in gadolinium single crystals below the Curie point, is investigated. The elastic softening of the c_{33} elastic constants, and its pressure dependence, is discussed in terms of the molecular-field model of the magnetic-interaction Hamiltonian. It was shown that the elastic softening in gadolinium is of a magnetoelastic origin. Within the framework of the model presented in this study, it is shown why the shear elastic modes c_{44} and c_{66} do not exhibit anomalous behavior in the spin-reorientation region of gadolinium. The reason for the negligible elastic anomaly in c_{11}, in this temperature region, is also discussed. The pressure dependence of the spin-reorientation temperature T_r can be explained in terms of the pressure contribution to the first anisotropy-energy constant K_1. This calculated value of the shift in T_r with pressure is in satisfactory agreement with the experimentally determined one. (auth)

16017 VALENCE, ELECTRONIC SPECIFIC HEAT, AND MAGNETIC SUSCEPTIBILITY OF ALPHA-CERIUM. Olmedo, C. F. E.; Lopez, A.; Alascio, B. (Comision Nacional de Energia Atomica, Bariloche, Argentina). Solid State Commun.; 12: No. 12, 1239-1242(15 Jun 1973).

A sixfold degenerate Anderson Hamiltonian, which includes the Coulomb repulsion between localized and band states in the mean field approximation following Ramirez and Falicov, is treated in the limit of infinitely correlated 4f states and to second order in the mixing parameter. Assuming a line width $\Gamma \approx 0.02$ eV, the results obtained at low temperatures and 11 kbar are a valency of 3.76 and sizeable contributions from the 4f levels to the electronic specific heat and magnetic susceptibility of alpha Ce. Thus it is shown that the highly correlated picture necessary to the explanation of the alpha–gamma transition by Ramirez and Falicov (Phys. Rev., B3: 2425 (1971)) need not be abandoned in order to explain the anomalies in alpha Ce. (auth)

16018 MAGNETIC PROPERTIES OF THE PSEUDOBINARY INTERMETALLIC COMPOUNDS $Ce_{1-x}R_xAl_3$. Niculescu, V.; Poop, I. Stud. Univ. Babes-Bolyai, Ser. Phys.; 18: No. 1, 35-39 (1973). (In Rumanian).

All forms of diamagnetic and paramagnetic contributions to the susceptibility χ_0 (which was temperature-independent), supplemental to the temperature-dependent Langevin type of paramagnetism, were evaluated for the pseudobinary compounds $Ce_{1-x}R_xAl_3$ (where R = Gd, Er, or Tb). Determinations were also made of the Pauli type of paramagnetic susceptibility, orbital susceptibility, as given by the p and d electrons of the conduction band, the diamagnetic susceptibility of the completed electron shells, and the Landau type of susceptibility of conduction electrons. A relation was established between the Pauli susceptibility in a free electron approximation and the susceptibility of conduction electrons from pseudobinary compounds by means of the amplification factor f of the density of the states at the Fermi level, with correspondence between the calculated values and the experimental results for χ_0 being quite adequate. (tr-auth)

16019 X-RAY ANALYSIS OF TANTALUM FILMS TRIODE-SPUTTERED IN ARGON–OXYGEN MIXTURES. Westwood, W. D. (Bell Northern Research, Ottawa). Thin Solid Films; 15: 15-30 (1973).

Tantalum films triode-sputtered in argon–oxygen mixtures were examined in an x-ray diffractometer, a wide-film Debye–Scherrer camera, and a powder camera. When no oxygen is added to the argon, the films contain approximately 4 at. % oxygen, have a resistivity of 50 μΩ cm, and crystallize in the bcc Ta phase with a slight preferred orientation. As the oxygen content of the sputtering is increased to give an oxygen concentration of approximately

10 at. % in the film, the resistivity increased to 200 μΩ cm and the bcc Ta phase is replaced by the tetragonal β-Ta phase with a strong (100) orientation. The orientation becomes more random as the oxygen concentration increases and the diffraction lines become broader due to smaller grain size. The β-Ta phase is present at oxygen concentrations up to at least 18 at. %. For oxygen concentrations between 19.6 and 25.7% only a few weak diffraction lines are observed, and it is not possible to distinguish unambiguously between the bcc and β-Ta phases. At concentrations of 38.7% and higher, only the (111) reflection from β-Ta_2O_5 is observed and the grain size is approximately 50 Å. In this region, the resistivity increases rapidly from 401 to 2862 μΩ cm as the oxygen concentration increases from 38.7 to 57.5 at. %. (3 tables, 5 figures, 22 references) (auth)

16020 RESISTIVITIES OF $CeAl_3$ AND $LaAl_3$ COMPOUNDS UNDER PRESSURE. Percheron, A.; Achard, J. C.; Gorochov, O.; Cornut, B.; Jerome, D.; Coqblin, B. (Centre National de la Recherche Scientifique, Meudon-Bellevue, France). Solid State Commun.; 12: No. 12, 1289-1294(15 Jun 1973).

The electrical resistivity of $CeAl_3$ and $LaAl_3$ compounds was measured in the 1.3 to 300°K temperature range and under pressure up to 17 kbar. The pressure dependence of the resistivity above 25°K is theoretically explained by the influence of the crystalline field on the Kondo effect, while the variation of the resistivity at low temperatures or with pressure cycles is qualitatively discussed. (auth)

16021 MAGNETIC EXCITATIONS IN Pr. Second Look. Hsieh, Y. Y. (Saint Francis Xavier Univ., Antigonish, Nova Scotia). Solid State Commun.; 12: No. 12, 1271-1273(15 Jun 1973).

The temperature-dependent excitation spectra of the paramagnetic excitons in the dhcp praseodymium single crystal are derived in the RPA of the double-time Green function method. Results are compared with the experimental data using Rainford's (Phys. Rev. Lett., 26: 1254(1971)) level scheme. (auth)

16022 CINEMATIC OBSERVATIONS OF THE $\alpha \rightleftharpoons \beta$ TRANSFORMATIONS IN PLUTONIUM. Liptai, R. G. (Univ. of California, Livermore); Friddle, R. J.; Rechtien, J. J. J. Nucl. Mater.; 47: No. 1, 110-112(May 1973).

A motion-picture camera at 16 frames/s was used on a metallograph (polarized light, 50×) to record the $\alpha \rightarrow \beta \rightarrow \alpha$ transformation at 3°C/min. On heating ($\alpha \rightarrow \beta$), the transformation interface is smooth and advances uniformly. On cooling ($\beta \rightarrow \alpha$), the interface is very irregular; the transformation proceeds by the rapid transformation of long, thin plates that thicken and grow together. Thus, the $\alpha \rightarrow \beta$ transformation appears to proceed by a nucleation-and-growth mechanism, while the $\beta \rightarrow \alpha$ transformation is martensitic. (DLC)

16023 BOUNDARY OF THE TWO-PHASE REGION OF SOLID SOLUTIONS Mo(Ni,Cu) AND Cu(Ni,Mo) IN THE SYSTEM Mo–Cu–Ni. Kozlova, R. F.; Rabkin, V. B.; Losev, L. Ya.; Pashchenko, E. F. Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 56-60(May 1973). (In Russian).

On the basis of the results of microstructural and x-ray phase analyses, it was established that a two-phase region of solid solutions Mo(Ni,Cu) and Cu(Ni,Mo) coexistence joins the Mo–Cu side of the system and is limited by angular section Ni: Cu = 1:4. The two-phase region is contiguous to the three-phase one, in which two ternary solutions and σ-phase coexist on the base of the compound MoNi. (auth)

16024 ELECTROPHYSICAL PROPERTIES OF HOT-MOLDED NIOBIUM PENTOXIDE. Tkachenko, I. G.; Fen, E. K. (Inst. of Problems of Mathematics, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 78-81(May 1973). (In Russian).

Electric properties of Nb_2O_5 in a solid state were studied within a temperature range of 20 to 1450°C under constant and alternating current, in the air and in vacuum. It was established that the conductivity of Nb_2O_5 possesses a considerable ionic component; the negative temperature coefficient of electric conductivity is observed in the temperature range 20 to 150°C. Conductivity under different current directions depends on the history of the sample and has a different value, which is associated with the formation of an electrode layer of an increased resistance. The primarily electronic nature of niobium pentoxide's conductivity is confirmed. (auth)

16025 COMPRESSION OF ZIRCONIUM SINGLE CRYSTALS PARALLEL TO THE c-AXIS. Akhtar, A. (Univ. of British Columbia, Vancouver). J. Nucl. Mater.; 47: No. 1, 79-86(May 1973).

Zirconium single crystals were deformed in compression along the c-axis between 78 and 1100°K. Plastic deformation occurs by $\{11\bar{2}2\}$ twinning up to a temperature of 800°K, whereas twins of the type $\{10\bar{1}1\}$ in conjunction with (c + a) slip were observed to initiate plastic flow at temperatures above 800°K. The slip plane was identified as $\{10\bar{1}1\}$. An increasing flow stress with temperature, high work-hardening rate, and load drops is associated with $\{11\bar{2}2\}$ twinning. A rapidly decreasing flow stress, high strain-rate sensitivity, low work-hardening rate, and absence of yield drop characterize the region above 800°K where $\{10\bar{1}1\}$ slip and twinning are observed. Localized recrystallization in deformation bands occurs above 973°K. The deformation behavior is compared with that in other metals having the hcp structure. (11 figures, 16 references) (auth)

16026 NATURE OF PHASE INTERACTIONS IN MAGNESIUM ALLOYS OF THE Mg–Nd–Y SYSTEM. Sviderskaya, Z. A.; Padezhnova, E. M. pp 6-10 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (Ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

Alloys of the Mg–Nd–Y system with a total neodymium plus yttrium content of up to 40 wt % are studied by thermal and microstructural analysis. It is shown that in the case of equilibrium with neodymium and yttrium solid solutions, manganese contains the Mg_9Nd and $Mg_{24}Y_5$ phases. A noninvariant eutectic transformation occurs in the system at a temperature of 536 ± 2°C. (IAA)

16027 SOLUBILITY OF CERIUM AND ZIRCONIUM IN COPPER IN THE SOLID STATE. Korol'kov, A. M.; Lysova, E. V. pp 17-20 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The individual and joint solubilities of Ce and Zr in Cu were evaluated by microstructural analysis and measurements of the electrical resistance and microhardness. The phase region limits were established in the Cu corner of the Cu–Ce–Zr ternary system. The solubility of Ce in Cu at 850, 800, and 20°C was 0.10, 0.045, and 0.03 at.%. The solubility of Zr in Cu at these temperatures was 0.10, 0.04, and 0.015 at.%. The mutual solubility of Ce and Zr in Cu at 800 and 20°C was 0.045 to 0.04 and 0.03 to 0.015 at.%, respectively. The phases Cu_6Ce and Cu_3Zr were found in equilibrium with the ternary α-solid solution of Cu. Alloying of Cu with Ce and Zr increased its strength and heat stability, with a small decrease in its electrical conductivity. (tr-auth)

16028 PHASE DIAGRAM OF Mg–Pr. Bochvar, N. R. pp 21-23 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

A portion of the Mg–Pr phase diagram was constructed up to 35 wt % Pr, and the solubility of Pr in solid Mg was determined, using thermal and metallographic analyses and electrical conductivity measurements. A eutectic composition ($\alpha + Mg_3Pr$) crystallized at 572°C and contained 21 wt % Pr. The solubility of Pr in solid Mg was 2.0, 1.3, 0.9, 0.5, 0.35, and 0.2 wt % at 575, 540, 500, 400, 300, and 200°C, respectively. (tr-auth)

16029 DEPENDENCE OF THE VELOCITY OF ULTRASOUND ON COMPOSITION IN BINARY MAGNESIUM ALLOYS. Drits, M. E.; Pokhlin, L. L.; Zusman, L. L. pp 23-28 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

The rate of propagation of ultrasound was studied as a function of composition in a series of binary alloys of Mg with Cd, Pb, Al, Sn, Zn, Nd, Ca, Ce, La, Cu, and Si. In the majority of the systems, an increase in the content of the alloying element resulted in a decrease in the speed of sound, but to varying degrees. Exceptions were Mg–Al and Mg–Si, for which the trend was reversed. In the system Mg–Ca, the velocity of sound was practically independent of the % Ca. A lowering of the sound velocity was generally associated with a rise in the density of the binary alloy. (tr-auth)

16030 EFFECT OF ALLOYING ON DAMPING PROPERTIES OF MAGNESIUM AND SOME OF ITS ALLOYS. Drits, M. E.; Pokhlin, L. L.; Sheredin, V. V.; Shul'ga, Yu. N. pp 35-39 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian)

Ten binary and eight ternary systems were used to evaluate the effect of alloying on the damping property of Mg and Mg–0.6% Zr, the alloying metals being Cd, Al, Mn, Ni, Si, Zr, Ca, mischmetal, La, Nd, Zn–Zr, Zr–Mn, Zr–Ba, Zr–Ni, Zr–Cu, Zr–Sr, Zr–La, and Zr–Ca. Samples were subjected to a twisting escalation near 30 Hz with an initial amplitude of 3.3×10^{-4}. The damping capacity was characterized by the magnitude of the decrement of damping δ. The value of δ decreased in proportion to the amount of the alloying element in all systems from 0.2 to 0.3 and 0.1 to 0.001, with the exception of the Mg alloys with Zr, Ni, and Zr–Mn. Much lower values of δ (to 0.001) were achieved with additions of Nd, Al, Cd, and Zn. (tr-auth)

16031 INFLUENCE OF ANNEALING VACANCIES ON BETA-PHASE TRANSFORMATION DURING TEMPERING OF Ti ALLOYS WITH 15 TO 25% Mo. Novikov, I. I.; Kasparova, O. V.; Pol'kin,

I. S. pp 45–48 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian)

The influence of various conditions of annealing from the beta region on the decomposition kinetics of the beta solution in titanium alloys with 15, 20, and 25% molybdenum is investigated. It is shown that an increase in the annealing temperature and acceleration of post-annealing cooling lead to an increase in the strain-hardening and contraction effects during tempering at temperatures between 300 and 500°C. This is attributed to an increase in concentration of annealing vacancies. (IAA)

16032 RECRYSTALLIZATION DIAGRAM AND MECHANICAL PROPERTIES OF VMDZ ALLOY IN DEPENDENCE ON DEGREE OF DEFORMATION AND ANNEALING TEMPERATURE. Drits, M. E.; Gur'ev, I. I.; Bakhtina, T. M. pp 64–68 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian)

The effect of structure on the mechanical properties of the alloy Mg–Zn–Zr–Cd–La was investigated. The maximum strength was achieved by a crystallized or partially recrystallized structure, and it was gradually lowered in proportion to the increase in the degree of recrystallization and the grain size. The optimum annealing temperature was 250 to 300°C. A recrystallization diagram was constructed for the alloy VMDZ, and a graph showing the mechanical properties as a function of grain size and annealing temperature was prepared. (tr-auth)

16033 INFLUENCE OF INTERMETALLIC PHASES ON THE NUCLEATION OF MICROCRACKS IN BINARY ALUMINUM ALLOYS. Drits, M. E.; Korol'kov, A. M.; Guk, Yu. P.; Gerasimova, L. P. pp 91–95 of Struktura i Svoistva Legkikh Splavov. Korol'kov, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian)

The influence of intermetallic phases, which form when aluminum is alloyed with titanium, zirconium, chromium, manganese, iron, or nickel, on the nucleation and propagation of microcracks is studied at 300°C in uniaxial tension. It is shown that the influence of individual alloying elements on the mechanical properties of the alloys can be determined by studying the nature of microcrack nucleation and propagation and their interaction with excess intermetallic phases. The six alloys tested included 3% Zr, 10% Mn, 3% Ti, 10% Ni, 5% Cr, and 10% Fe. (IAA)

16034 X-RAY PHASE ANALYSIS OF MIXTURES OF FORMS OF ZrO_2. Vorozhko, A. V.; Polishchuk, P. A. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 9, 1395(Sep 1972).

Translated from Zavod. Lab.; 38: No. 9, 1110(Sep 1972).

Zirconium dioxide can be made as cubic, monoclinic, and tetragonal modifications. Mixtures of forms of ZrO_2 were analyzed with a URS-50IM diffractometer with a chart recorder on filtered copper radiation. Technical samples were analyzed and compared with the characteristic patterns for ZrO_2 modifications and a qualitative analysis is drawn up. If monoclinic ZrO_2 is mixed with the cubic or tetragonal form, the phase composition is determined quantitatively by the external-standard method, with artificial mixtures as the standards. (MCW)

16035 THERMAL AND ELECTRIC CONDUCTIVITIES OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS, PARTICULARLY AT HIGH TEMPERATURES. Wulff, G. Diss. Nr. 4561. Zurich; Eidgenoessische Technische Hochschule (1970). 88p. (In German).

Thesis.

It was demonstrated that an electron beam was well suited for heat-conduction measurements on metallic samples. The transmission of the beam power to the sample without contact was in no way influenced by the sample temperature. Since only the sample was heated, no upper temperature limit existed for conduction measurements. For temperatures above 1200°K, heat conduction was determined through the radiation behavior of a cylindrical sample. The heat-conduction numbers, measured on relatively large rods of single crystals of either tungsten or molybdenum, deviated partly from the results of other investigators. (HBG)

16036 ADSORPTION OF HYDROGEN, NITROGEN, AND ARGON ON RHENIUM POWDER. The Surface Area of Rhenium. Kubicka, H. (Inst. of Low Temperature and Structural Research, Wroclaw). Rocz. Chem.; 47: No. 3, 599–616(1973).

Adsorption isotherms of hydrogen, nitrogen, and argon on rhenium powder at temperatures 77.4 to 673°K were determined within the range of 0.01 to 200 torr. The investigations comprised the influence of chemisorbed hydrogen on low-temperature adsorption of gases, as well as that of chemisorbed oxygen and nitrogen on high-temperature chemisorption of hydrogen. Low-temperature adsorption was analyzed by applying the BET and DR equations. (9 figures, 33 references) (auth)

16037 DETERMINATION OF AVERAGE PARTICLE DIAMETER OF ULTRAFINE TUNGSTEN AND TUNGSTEN CARBIDE POWDERS BY THE FISHER METHOD. Storin, A. Cercet. Met.; 13: 713–720(1972). (In Rumanian).

A modified Fisher method for measuring the mean particle size of ultrafine W and WC powders is described. (Metals Abstr.)

16038 MAGNETIC STRUCTURE OF $NdZn_2$. Debray, D.; Sougi, M. (Service de Physique du Solide et de Résonance magnétique, Centre d'Etudes Nucléaires de Saclay, BP n°2–91, Gif–sur–Yvette, France). J. Chem. Phys. 58: No. 5, 1783-1786 (1 Mar 1973).

Neutron powder diffraction measurements reveal that $NdZn_2$, having the body-centered orthorhombic crystal structure ($CeCu_2$-type), undergoes magnetic ordering below 21 ± 1°K. The magnetic structure can be described by the composite of a sinusoidal transverse wave moment alignment polarized in the b axis direction and propagating along the c axis, and a ferromagnetic component along the b axis. The propagation wavelength and amplitude of the sinusoidal component at 4.2°K are, respectively, 2.35 in units of c and 1.7 ± 0.1 μ_b. The ferromagnetic component equals ≈ 0.7 μ_b. Results of magnetization measurements are consistent with the above findings. (auth)

16039 NEW METALLIC MATERIALS IN THE 70's: OPPORTUNITIES AND CHALLENGES. Shank, M. E. (Pratt and Whitney Aircraft, East Hartford, CT). pp 1–29 of Opportunities in Materials. Shaw, M. C. (ed.). Pittsburgh; Carnegie Press (1971).

From fourth Buhl international conference on materials; Pittsburgh, Pennsylvania, USA (16 Nov 1971). See CONF-711154–.

New and improved metallic materials have been developed that are now in use in aerospace, communications, power generation, transportation, and environmental control. New usage for older materials, combinations of materials, new processing for old compositions, and new compositions are discussed. Economy, reliability, availability, technical feasibility, and social/environmental interactions are considered for some newer metallic materials including high temperature superalloys, refractory metals, composites, directionally solidified superalloys and eutectics, and TD Ni and TD NiCrAlY. In the 1970's, large aircraft contained 75% Al and steel, 15% Ti and superalloys, and 10% other materials. A major factor in the growth of aircraft transportation is improvements in the gas turbine engine. Two metal matrix types expected to find use in military engines for low-temperature application BORSIC TM/AL and BORSIC TM/Ti. Some materials studied for high-temperature composites are boron on tungsten, silicon carbide on tungsten, high-strength and high-modulus graphite, alumina, and tungsten. Whisker materials studied are alumina, silicon carbide, and silicon nitride. (18 figures, 16 references) (MCW)

16040 NEW METALS PROCESSING TECHNIQUES. Dieter, G. E. (Drexel Univ., Philadelphia). pp 30–66 of Opportunities in Materials. Shaw, M. C. (ed.). Pittsburgh; Carnegie Press (1971).

From fourth Buhl international conference on materials; Pittsburgh, Pennsylvania, USA (16 Nov 1971). See CONF-711154–.

Metal processing techniques involve deformation that change the shape of a piece of metal and at the same time alter or control its properties. Progress in metal deformation processing falls into two categories. The first concerns new processes or approaches to producing shapes and parts. The second category involves advances in older, established processes such as rolling, forging, etc. Fundamentals of hot working, dynamic recovery, dynamic recrystallization, and fracture in metalworking are discussed to review the conventional processes. Hydrostatic pressure and superplastic forming are two new processes discussed. Diffusion bonding is being put to new uses. The new direction for powder fabrication is greater emphasis on deformation and less emphasis on sintering as the principal densification step. Powder metallurgy forging and fabrication of superalloy shapes by powder metallurgy are in extensive development. 27 references. (MCW)

16041 SUPERIOR NEW ALLOYS THROUGH PARTICLE METALLURGY. Dulis, E. J. (Crucible Inc., Pittsburgh). pp 336–351 of Opportunities in Materials. Shaw, M. C. (ed.). Pittsburgh; Carnegie Press (1971).

From fourth Buhl international conference on materials; Pittsburgh, Pennsylvania, USA (16 Nov 1971). See CONF-711154–.

The P/M process is generating a new consideration for making large-sized products of high-alloy materials. In addition to making alloys of unique compositions and combinations, the P/M process is amenable to making various types of composites. Conventional alloys of higher quality can be produced in many cases. A method to commercially produce high-speed tool steel mill products by P/M at Crucible Inc., Pittsburgh, Penn. is described. A compar-

ison of conventional cast-and-wrought high-speed tool steel products with P/M products shows that P/M products maintain fine carbide size and homogeneous distribution regardless of fine uniformly distributed primary carbide phase in its relationship to grain size, tool life, and grindability. P/M high speed steels show reduced out-of-roundness or improved uniformity of size change that occurs during the final hardening heat treatment of large tools. Much work is being done on P/M superalloys and titanium alloys. (MCW)

16042 NITROGEN–NITRIDE EQUILIBRIA IN MOLTEN Pr–Sn ALLOYS. Fuwa, A.; Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., CA). High Temp. Sci.; 5: No. 3, 165-175(Jun 1973).

The nitride formation reaction in 0.68 to 2.50% (praseodymium) Pr–Sn alloys has been studied over the temperature range of 1447 to 1670°C by a modified Sieverts technique. The equilibrium data on the PrN reaction makes it possible to provide the standard free energy of this reaction for the weight percent activity scale as $Pr(\%) + \frac{1}{2}N_2(g) = PrN(s)$; $\Delta G^0 = -32{,}600 + 16.8T$. Expressions for the ΔG^0 and γ^0_{Pr} on the mol. fraction activity scale have been approximated by estimation methods. The stoichiometry of the nitride formed has been shown to be $PrN_{1.0}$. (auth)

16043 MECHANICAL BEHAVIOR OF A FAST-BURST-REACTOR FUEL CANDIDATE. Yao, E. Albuquerque, NM; Univ. of New Mexico (1972). 296p. University Microfilms Order No. 73-16,584.

Thesis (Ph. D.).

A study was made of the mechanical properties, deformation characteristics, and fracture behavior of a fast burst reactor fuel candidate: γ-phase U–6 wt % Mo. The mechanical properties were determined from 77 to 798°K using an environment-controlled elevated-temperature tensile testing system and a cryogenic-temperature tensile testing apparatus. The activation enthalpy and volume and other strain rate parameters required for analysis of the deformation mechanisms were calculated from the data obtained by strain rate cycling and stress relaxation measurements. Metallographic and fractographic methods were conducted to characterize the plastic deformation and fracture behavior. Quantitative characterization of the fracture surfaces was conducted to establish the fracture mechanism as a function of testing temperature. Correlation of the data with various parameters and analytical expressions was also performed. A degree of understanding that is based on existing theories was obtained for the mechanical behavior of U– 6 wt % Mo. The temperature-dependent mechanical behavior of U–6 wt % Mo is similar to that of other high-strength bcc metals and alloys. Significance of the results to fast burst reactor applications is presented. (Diss. Abstr. Int., B)

16044 1972 ANNUAL BOOK OF ASTM STANDARDS. Part 7. Nonferrous Metals and Alloys (Including Corrosion Tests); Electrodeposited Metallic Coatings; Metal Powders; Surgical Implants. Philadelphia; American Society for Testing and Materials (1972). 1180p. $33.00.

This volume is one of 33 and contains all current formally approved ASTM standard and tentative test methods, definitions, recommended practices, classifications, specifications and other related material. (JRD)

16045 SURFACE RESISTANCE OF CADMIUM IN A MAGNETIC FIELD. Lavrova, V. V.; Medvedev, S. V.; Skobov, V. G.; Fisher, L. M.; Yudin, V. A. (Ioffe Inst. of Physics and Tech., Leningrad) Zh. Eksp. Teor. Fiz.; 64: No. 5, 1839-1854(May 1973). (In Russian).

Doppler-shifted electron and hole cyclotron resonance and its effect on the surface resistance of cadmium in the radio-frequency range are studied theoretically and experimentally. Resistance oscillations due to excitation of electron and hole dopplerons in a plate and also impedance peculiarities due to the presence of thresholds in the spectrum of the waves are singled out by employing circular polarizations of the exciting field. The influence of dopplerons on the surface resistance of a massive sample on diffuse reflection of the carriers by the surface is considered for a simple model of a paraboloid-shaped Fermi surface. It is shown that the presence of thresholds in the doppleron spectrum leads to break in the surface resistance as a function of magnetic field strength. The field strength dependencies of the impedance are in agreement with the experimental results. The electron doppleron spectrum is determined from the plate impedance oscillations and it is indicated how the nonlocal conductivity of the metal can be determined from these data. (auth)

16046 CREEP CHARACTERISTICS OF AISI 316 and 316L TYPE AUSTENITIC STAINLESS STEELS USED IN NUCLEAR CONSTRUCTIONS. Boulisset, R.; Dollet, J. (Societe Creusot-Loire, Paris). Soudage Tech. Connexes; 27: No. 3, 103-127(Mar 1973). (In French).

From meeting of the Welding Engineering Society; Paris, France (14 Sep 1972).

The construction of sodium-cooled breeder reactors led to much investigation on the properties of austenitic stainless steels (types 316 and 316L). In this way the conventional characteristics of creep rupture and the resistance associated with a 1% creep deformation were determined for temperatures between 500 and 720°C and time intervals ranging from a few dozen hours to 100,000 or 200,000 hours. The resistance to tertiary creep and the ductility characteristics associated with creep rupture were also determined. (FR)

16047 GENERAL CHARACTERISTICS OF POINT DEFECTS IN METALS. Quere, Y. (CEN, Fontenay-aux-Roses, France). J. Microscop.; 16: No. 2, 111-124(1973). (In French).

From annual meeting of the French Society of Electron Microscopy; Nantes, France (29 May 1972).

The general characteristics of point defects are discussed, current knowledge on the subject being presented. It is shown how experiments have been able to verify certain theoretical considerations especially in the theory of elasticity. Emphasis is given to the differences between the various types of radiation used to produce point defects. Current experimental projects are described. (FR)

16048 MATERIALS CREEP BEHAVIOR AND ELEVATED TEMPERATURE DESIGN. Blackburn, L. D.; Tobin, J. C.; Moen, R. A. (Hanford Engineering Development Lab., Richland, WA). Nucl. Technol.; 16: No. 1, 278-286(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

New elevated temperature design criteria are based on time-dependent material deformation behavior. These criteria establish time-dependent allowable stresses which are evaluated from a consideration of three quantities: (1) the stress to produce rupture, (2) the stress to produce the onset of tertiary creep, and (3) the stress to produce 1% total strain. These quantities must be determined over a time range from 10 to 200,000 h for temperatures from 800 to 1300°F. Allowable stress values for Types 304 and 316 stainless steel are derived from an analysis of experimental creep data. Stress quantities associated with rupture and tertiary creep are largely determined from existing data and analysis methods, while new data and analysis procedures are employed to evaluate the stress to produce 1% strain. An analytical formulation describing the transient and steady-state creep strain response observed in constant-load, constant-temperature tests is developed for use in structural analysis. This formulation is used with an equation-of-state approach based on strain hardening for application to variable load or temperature conditions. (11 figures) (auth)

16049 CREEP DATA ACQUISITION AND APPLICATION TO REACTOR COMPONENT DESIGN. Ayers, D. J. (Combustion Engineering, Inc., Windsor, CT); Cullen, T. M. Nucl. Technol.; 16: No. 1, 287-296(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

A unique data acquisition and process control system was designed for the generation of creep constitutive equations. The system is capable of measuring and recording very small rapidly changing strains during primary creep as well as the very large strains in tertiary creep. The data are automatically reduced to equations relating stress, strain, temperature, and time which can be put directly into nonlinear finite-element stress analysis programs. (11 figures) (auth)

16050 FATIGUE-CRACK GROWTH IN 20% COLD-WORKED TYPE 316 STAINLESS STEEL AT ELEVATED TEMPERATURES. James, L. A. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 316-322(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The fatigue-crack propagation behavior of 20% cold-worked Type 316 stainless steel was characterized over the temperature range 75 to 1300°F using linear-elastic fracture mechanics. It was found that, at a given level of stress intensity factor, increasing the temperature produced a significant increase in the rate of fatigue-crack propagation. At 1000°F, decreasing the cyclic frequency tended to increase the crack growth rate. The data also suggest that, at a given temperature, the crack growth rate is slightly higher when the direction of crack extension is parallel to the rolling direction than when the crack extension is perpendicular to the rolling direction. Comparison with data for solution-annealed Type 316 fatigue-cycled under similar conditions indicates that, at a given temperature, cold working tends to

increase the resistance to fatigue-crack propagation. (7 figures, 19 references) (auth)

16051 TRANSVERSE MAGNETORESISTANCE AND HALL RESISTIVITY IN PURE CADMIUM AND IN DILUTE CRYSTAL ALLOYS OF Cd–Ag AND Cd–In. Lilly, D. A. Lafayette, IN; Purdue Univ. (1972). vp.

Thesis (Ph. D.).

The Hall resistivity $\rho_{21}(H,T)$ ($\vec{H}||[0001]$, $\vec{J}||[11\bar{2}0]$) and transverse magnetoresistance $R(H,T,\theta)$ were measured on pure cadmium single crystals and on dilute crystal alloys of Cd–Ag and Cd–In in the temperature range 1.4 to 30K and for field strengths from 1.7 to 24 kG. The residual resistance ratios of the pure samples varied from 16,000 to >20,000, those of the alloys from 62 to ~20,000 (corresponding to controlled-impurity concentrations from 500 to 1 ppmw). In the pure samples, $\rho_{21}(H,T)$ reversed sign for T < 5K, in agreement with previous published results on pure cadmium and a number of Cd–Zn crystal alloys, in which the behavior of $\rho_{21}(H,T)$ for $1.4K \leq T \leq 10K$ was semi-quantitatively described in terms of inter-sheet scattering. In the alloys of this study, at the lowest temperatures and highest fields, ρ_{21} approaches a positive, constant value even for concentrations of Ag or In as low as 1 ppmw. It is shown that inter-sheet scattering cannot consistently account for this new behavior. A two-band model, based on published measurements of the temperature dependences of hole and electron mean free paths in cadmium, is found to be only qualitatively successful in describing $\rho_{21}(H,T \leq 10K)$ in the alloys for which ρ_{21} remains positive. It is suggested that combinations of orbital scattering times, $\tau(T)$, with various temperature ranges of dominance, must be considered for an accurate description of $\rho_{21}(H,T)$ in these alloys. (Diss. Abstr. Int., B)

16052 YIELD AND FRACTURE MODEL FOR Ti–6Al–4V TITANIUM AND 7075-T6 ALUMINUM. Pendleton, R. L. Rolla, MO; Univ. of Missouri (1972). 95p. University Microfilms Order No. 73-17,059.

Thesis (Ph. D.).

A series of experiments was conducted on two commonly used structural metals in several different environmental pressures so that a graphical representation of the material response both to yielding and fracture could be ascertained. It was further intended to show that parameters defined and called effective stress, effective strain, and pressure are useful parameters for graphically representing the material response. The final goal was to show that the graphical representation does, in fact, predict the yield and fracture for a simple forming process. The forming process, conducted in various environmental pressures, was the folding of a thin plate. (Diss. Abstr. Int., B)

16053 MECHANICAL PROPERTIES OF WELD, BASE METAL, AND COATED COLUMBIUM FS85. Tavassoli, A. A. Weld. J. (N.Y.); 52: No. 7, 323s-327s(Jul 1973).

Bend ductility and elevated temperature tensile properties of sheet FS85 have been evaluated. Bend tests were conducted between 260 to –184°C and tensile tests up to 1427°C. The as-received FS85 had an unusually high ductile-to-brittle transition temperature, but a 1 h anneal restored ductility in both as-received and welded materials. There was a slight decrease in tensile strength and elongation of FS85 after gas tungsten-arc (GTA) or electron beam (EB) welding. Postweld anneal of the welded specimens resulted in a severe reduction in elongation. The R512E coatings (Si-20Cr-20Fe) on both welded and base metal FS85 materials had a uniform thickness and resulted in an equal substrate consumption. Nevertheless, R512E coating also resulted in a severe reduction in tensile elongation. In view of the marked reductions in elongation of welded and coated FS85 material, detailed evaluation of FS85 welded panels for application in the thermal protection system (TPS) of the space shuttle and aerobraking system of the space tug is necessary. (auth)

16054 THERMODYNAMIC PROPERTIES OF LIQUID ALLOYS OF THE POTASSIUM–INDIUM SYSTEM. Bykova, M. A.; Morachevskii, A. G. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 91-94(1973). (In Russian).

The emf of a cell with a solid electrolyte containing K^- ions was measured at 720 to 810°K; showing a linear relationship for the emf-temperature function, K/solid electrolyte/K, In. Two equilibrium constants were incorporated into the expressions for calculating γ_K and γ_{In}, the corresponding activity coefficients, necessitated by the two simultaneous equilibria: $K + In \rightleftharpoons KIn$, and $K + 2In \rightleftharpoons KIn_2$. (KSW)

16055 CdSb–Ag SECTION OF THE TERNARY SYSTEM Cd–Sb–Ag. Belotskii, D. P.; Galichanskii, V. G. (Lvov Polytechnic Inst.). Ukr. Khim. Zh.; 39: No. 4, 397-399(Apr 1973). (In Russian).

The CdSb–Ag section of the phase diagram for the Cd–Sb–Ag system was studied using thermal and x-ray analyses and microhardness tests. The formation of the compound AgCdSb with a cubic lattice, a = 6.3100 Å, congruently melting at 430°C, was established. The specific electroconductivity and the thermal emf of the CdSb–Ag system were measured on the 20°C isotherm. (KSW)

16056 PLASTIC DEFORMATION OF SINGLE CRYSTALS OF NIOBIUM. Kubin, L. P.; Jouffrey, B. (CNRS, Toulouse). Phil. Mag.; 27: No. 6, 1369-1385(Jun 1973). (In French).

Tensile tests were performed on high-purity niobium single crystals between 2.17 and 300°K. Yield stresses, activation volumes and energies and dislocation structures were investigated. It seems that three different deformation mechanisms are operating, each of them in a definite temperature range. At the lower temperatures, very simple experimental laws were found. These experimental results are compared to the existing models for the yield stress of bcc metals. (auth)

16057 HEAT CAPACITY AND DERIVED THERMODYNAMIC FUNCTIONS OF THE ZETA PHASE IN THE Pu + Zr SYSTEM BETWEEN 15 AND 373 K. Sandenaw, T. A.; Harbur, D. R. (Los Alamos Scientific Lab., NM). J. Chem. Thermodyn.; 5: No. 4, 459-465(Jul 1973).

Heat capacities of the zeta phase in the Pu + Zr system (2.55 mole % Zr) were determined between 15 and 373°K, and values of the derived thermodynamic functions were calculated. Low temperature C_p against T behavior indicates that the zeta phase is a stable phase below 373°K. A high density of states was suggested and a θ_D of 133°K was derived from the results. Values of $C_p(T)$, $S^0(T)$, and $-G^0(T) - H^0(O)/T$ were determined to be 7.29, 15.67, and 9.76 $cal_{th}K^{-1}$ mol^{-1} and $H^0(T) - H^0(O)$ to be 1761.4 $cal_{th}mol^{-1}$ at 298.15°K, from smoothed results. Uncertainty in the different thermodynamic function values was judged to be ±0.7%. (auth)

16058 FRICTION OF RHENIUM AT HIGH TEMPERATURES. Semenov, A. P.; Katsura, A. A.; Pozdnikov, V. V. Mashinostroene; No. 6, 80-84(1972). (In Russian).

The temperature relationships of the coefficient of friction of rhenium in a vacuum (10^{-4}–10^{-5} torr) was obtained in the case of the friction of two like specimens of rhenium against each other, and in case of the friction of a rhenium specimen against corundum ceramics (containing 0.6% MgO), on laboratory installations at temperatures of up to 1500°C. The presented experimental results testify to the high antifriction properties of rhenium at high temperatures in a vacuum and in inert gaseous media. (18 references) (JPRS)

16059 DILATOMETRIC METHOD OF EVALUATING TEMPERATURE STRESSES IN NICHROME–TUNGSTEN COMPOSITIONS. Gayduk, V. V.; Lavrenko, A. S.; Sukhanov, Yu. V. Probl. Prochnosti; No. 9, 108-111(Sep 1972). (In Russian).

A method is outlined for determining the internal thermal stresses in compositions with a matrix of EI435 alloy and tungsten wire. The procedure is based on analysis of dilatometric curves of expansion. It is shown that the matrix is subjected to tensile stresses at low temperatures and compressive stresses at high temperatures. It is shown how mechanical stresses influence the properties of the matrix as a whole. It is shown that the magnitude and sign of the internal stresses in the matrix must be taken into consideration when making parts from composition sheet material by bending or stamping. (JPRS)

16060 DEFORMATION AND RUPTURE OF MOLYBDENUM UNDER CREEP CONDITIONS. Zelenyuk, E. E.; Krivenyuk, V. V.; Semirog-Orlik, V. N. Probl. Prochnosti; No. 12, 85-89(Dec 1972) (In Russian).

Results are presented from creep and long-term strength tests in a vacuum at temperatures of 1,000 to 1,800°C, using specimens of technically pure molybdenum with concentrators in the form of apertures, as well as the results of studies of the concentration of deformations in a dangerous cross section near a notch. It is established that the influence of the concentrator on the strength of the material may be qualitatively and quantitatively different, depending on the test conditions; the stress concentration and deformation concentration factors in the elastic area coincide, the latter being independent of the plastic deformation over rather broad limits of deformation. (JPRS)

16061 REGULARITIES OF DEFORMATION AND RUPTURE OF REFRACTORY ALLOYS BASED ON MOLYBDENUM, NIOBIUM, AND TANTALUM WITH PROGRAMMED TEMPERATURE CHANGE. Troshchenko, V. T.; Uskov, E. I. Probl. Prochnosti; No. 12, 8-14(Dec 1972). (In Russian).

Results are presented from a combined study of creep and long-term strength of a number of refractory alloys based on Mo, Nb, and Ta under conditions of cyclically changing temperature; the regularities of deformation and rupture of refractory alloys are studied under these conditions. It is demonstrated that thermal cycling causes an increase in the creep rate, a reduction in plas-

ticity, and a significant reduction in time to rupture of the alloy studied in comparison with isothermal tests. An exponential dependence is established for the alloy studied between the stress and time to rupture. (JPRS)

16062 COMPOSITION OF MARTENSITE IN HARDENED ALLOYS OF THE SYSTEM Ti–Mo. Kolachev, B. A.; Mamonova, F. S.; Lyasotskaya, V. S. (Moscow Aviation Tech. Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 1, 115-116(1973). (In Russian).

O. G. Fedotov's proposition (1964) that martensite in Ti alloys may not correspond to the composition of the original β phase was tested by conducting x-ray analyses of samples of Ti–Mo alloys and measuring lattice parameters. The data confirmed Fedotov's suggestion that martensite phases may be saturated by β stabilizers according to a fixed threshold concentration. (KSW)

16063 ELECTRICAL RESISTIVITY AND EMISSIVITY OF SOME TRANSITION METALS AND ALLOYS IN THE HIGH-TEMPERATURE RANGE. Zhorov, G. A. High Temp. (USSR) (Engl. Transl.); 10: No. 6, 1202-1207(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 6, 1332-1334 (1972).

Results of a study of the emissivity and specific electrical resistivity of tungsten, rhenium, steel-15, tantalum, the titanium alloy Ti–4Al–2.1V–1.2Cr–7.65Mo, and the alloy Zr–1Nb at temperatures above 1000°K are presented. The emissivity and electrical resistivity of these materials were determined on the same specimen in a single experiment. Specimens in the form of tubes and rods were prepared from metal produced by powder-metallurgy methods (tungsten and rhenium) or by electron-beam melting (tantalum). The binary Zr–1Nb alloy was made from zirconium and niobium of commercial purity. (auth)

16064 MELTING POINT OF NIOBIUM. Berezin, B. Ya.; Kenisarin, M. M.; Chekhovskoi, V. Ya. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 6, 1092-1094(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 6, 1214-1217 (1972).

The melting point of 99.7% pure niobium was found to be 2469°C. This was the result of 21 measurements carried out using two EOP optical monochromatic pyrometers and a model of the absolute black body. (auth)

16065 TEMPERATURE DEPENDENCE OF INTERNAL FRICTION IN SINGLE CRYSTALS OF MOLYBDENUM. Merkulov, L. G.; Mukhailov, S. M.; Serebryannikova, N. P. (Leningrad Electrotechnical Inst.). Fiz. Metal. Metalloved.; 35: No. 3, 640-644 (1973). (In Russian).

Internal friction measurements were conducted in single crystals of Mo. The observed temperature dependence of internal friction differed sharply from the exponential relationship anticipated from the simple theoretical model. (tr-auth)

16066 EFFECT OF ANNEALING TEMPERATURE ON CHANGE IN CHEMICAL AND PHASE COMPOSITIONS OF GRAIN BOUNDARIES OF LOW-ALLOYED MOLYBDENUM. Arkharov, V. I.; Denisyuk, V. A.; Drachinskii, A. S.; Pisrenko, V. A.; Samoilenko, Z. A.; Trefilov, V. I. (Donetsk Physical-Technical Inst., USSR). Fiz. Metal. Metalloved.; 35: No. 3, 597-601(1973). (In Russian).

The concentrations of alloying elements, phase composition, and morphology of boundary separations were investigated in the alloy Mo–0.4% Ti–0.2% Zr–0.012% C using x-ray, structural, and electron microscope techniques. The chemical and phase compositions of the solid solution in the intercrystalline zone differed essentially from the compositions of thick crystals. The temperature trends of these changes were investigated. An interpretation of the observed changes was advanced on the basis of an inner adsorption hypothesis. (tr-auth)

16067 MUTUAL DIFFUSION IN NICKEL–TUNGSTEN AND PALLADIUM–TUNGSTEN SYSTEMS. Pimenov, V. N.; Ugaste, Yu. E. (Inst. of Metallurgy, Moscow). Fiz. Metal. Metalloved.; 35: No. 3, 590-596(1973). (In Russian).

Mutual diffusion in solid solutions was investigated in Ni–W and Pd–W systems. A concentration dependence of diffusion parameters was correlated with the path of the solidus line in diagrams of state for the subject systems. (tr-auth)

16068 ALPHA–OMEGA TRANSFORMATION IN TITANIUM AND ZIRCONIUM. Zil'bershtein, V. A.; Nosova, G. I.; Estrin, E. I. (Inst. of Metal Science and Physics of Metals, Moscow). Fiz. Metal. Metalloved.; 35: No. 3, 584-589(1973). (In Russian).

The $\alpha-\omega$ transformations in Ti and Zr were studied using electrical resistance techniques, x-ray analysis, dilatometry, and resistance to shear under pressure. Considerable hystersis of the conversion was detected near room temperatures. Corrections were advanced allowing for the t-p diagrams of Ti and Zr. (tr-auth)

16069 OPTICAL PROPERTIES OF DYSPROSIUM IN THE WAVELENGTH INTERVAL 1 TO 20 μ. Knyazev, Yu. V.; Noskov, M. M. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 35: No. 3, 478-483(1973). (In Russian).

The optical constants n and k were measured for massive polycrystalline Dy in the interval 1 to 20 μ at temperatures 80, 293, and 460°K. The plasma and relaxation frequencies of current carriers were determined from experimental data on the basis of a representation of conductivity electron division into groups with different kinetic characteristics. A resonance anomaly associated with a magnetic transformation was detected in the absorption spectrum of Dy. (tr-auth)

16070 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrit Mit Anhang Transplutonium-Elemente. Maerz 1973. Band 7, Heft 3. 244 Referate (Register-Nr. 903-1402), 61 Referate (Register Nr. 184-244T). (Plutonium Documentation. Abstract Journal with Appendix on Transplutonium Elements. Mar 1973. Vol. 7, No. 3. 244 Abstracts (Register No. 903-1402), 61 Abstracts (Register No. 184-244T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m. b. H. (1973). 140p. (In German and English).

16071 PHYSICO-CHEMICAL PROCESSES DURING THERMAL CYCLING OF SINGLE CRYSTALS OF MOLYBDENUM–RHENIUM ALLOYS. Savitskii, E. M.; Burkhanov, G. S.; Tetyueva, T. V. Fiz. Khim. Obrab. Mater.; No. 6, 77-83(1972). (In Russian).

The regularity of change in structure and properties of single crystals of Mo, Re, and their alloys as induced by thermal cycling was studied. A typical temperature interval for cycling was 1600 to 400°C, or 2400 to 400°C, with heating/cooling rates of 1000 to 1200°/min. Metallographic analyses were conducted after 150, 500, 750, 1500, and 3000 cycles in order to ascertain the average dislocation density and subgrain size and disorientation. The stability in structure and properties of Mo increased after alloying with Re within the limits of solid solution formation. The observations were interpreted in terms of changes in dislocated structure and electron shell alterations. (KSW)

16072 DUCTILE PROPERTIES OF CAST AND THERMALLY TREATED MOLYBDENUM ALLOYS. Belous, O. A.; Kotko, V. A.; Minakov, V. N.; Trefilov, V. I. Fiz. Khim. Obrab. Mater.; No. 6, 70-76(1972). (In Russian).

The influence of the thermal history (different annealing periods) of cast Mo alloys on their low-temperature ductility was studied. Physical factors which influence the intercrystalline brittleness and hardening of the grain boundaries are discussed. (KSW)

16073 WETTABILITY OF METALS BY WATER AS A FUNCTION OF TEMPERATURE. Stepanov, V. G.; Volyak, L. D.; Tarlakov, Yu. V. (Moscow Inst. of Aviation). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 9, 1371-1372(Sep 1972).

Translated from Zh. Fiz. Khim.; 46: No. 9, 2397-2398(Sep 1972).

The contact angles for water on stainless steel, niobium, tantalum, and nickel have been measured by different methods in the range 20 to 370°C. (auth)

16074 TEMPERATURE DEPENDENCE OF HEAT OF FORMATION OF MOLTEN EUTECTIC ALLOYS. Zalkin, V. M.; Vertman, A. A.; Gurevich, Yu. G.; Shvalev, Y. P. (Kuibyshev Polytechnic Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 9, 1269-1271(Sep 1972).

Translated from Zh. Fiz. Khim.; 46: No. 9, 2222-2224(Sep 1972).

A thermographic examination has been made of the effect of temperature of mixing on the relative changes in the heat of formation of molten alloys in several binary systems with a eutectic and in those with limited solubility in the liquid state. With rise in temperature the heat of mixing increases in the systems having a heterogeneous region, but decreases somewhat in the eutectic systems. Considerable absorption of heat on the formation of alloys in the eutectic systems is still recorded at temperatures 400 to 500°C above the melting point of the components. (auth)

16075 LOW-TEMPERATURE SPECIFIC HEAT OF BERYLLIUM COMPOUNDS OF THE FIRST TRANSITION–METAL SERIES. Kuentzler, R. (Univ., Strasbourg). J. Low Temp. Phys.; 7: No. 3-4, 309-318(May 1972).

The low-temperature specific heat of beryllium compounds $(Cr-Mn)Be_2$, $(Mn-Fe)Be_2$, and $(Fe_{0.95}T_{0.05})Be_2$, where T represents Cr, Mn, Co, or Ni, was measured between 1.2 and 4.2°K. The variation of the electronic specific heat coefficient γ as a function of the transition-metal electron/atom ratio is analyzed.

There is an increase of γ for $6 < e/a < 7$, a peak enhanced by clustering effects for $e/a \simeq 7.15$ due to the appearance of ferromagnetism, and a minimum for $e/a = 8$ for the transition from weak to strong ferromagnetism. (auth)

16076 NUCLEAR QUADRUPOLE INTERACTION STUDIES BY PERTURBED ANGULAR CORRELATIONS. Haas, H.; Shirley, D. A. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). J. Chem. Phys. 58: No. 8, 3339-3355 (15 Apr 1973).

A comperhensive study was made of the applicability of gamma-ray angular correlations to the determination of quadrupole interactions in metals and insulating solids. Dynamic effects were studied in solutions and gases. A total of fourteen gamma-ray cascades were employed. Several nuclear spins were confirmed and the quadrupole moments of ten excited nuclear states were determined or estimated from the data. Quadrupole coupling constants were determined for excited states of the following nuclei in metallic host lattices of the same element: ^{44}Sc, ^{99}Ru, ^{111}Cd, ^{117}In, ^{187}Re, ^{199}Hg. Coupling constants were also measured for the following isotope (lattice) combinations: ^{99}Ru(Zn, Cd, Sn, Sb), ^{100}Rh(Zn, Ru, Cu_5Zn_8, Pd_3Al, $PdPb_2$), ^{111}Cd(In, Hg, Tl, CdSb, Cd_3Ag, Zn, Ga, In, Sn, Sb, Bi, AuIn, InBi, In_2Bi), ^{115}In(Cd), ^{117}In(Cd, Sn), ^{131}I(Te), ^{181}Ta(HfB_2, $HfSi_2$), ^{204}Pb(Cd, In, Sn, As, Sb, Bi, Hg, Tl, $PdPb_2$). Systematic variations of e^2qQ with host-lattice structure were observed and host and solute properties were found to be separable to some extent for nontransition metals. The nuclei ^{111}Cd, ^{115}In, ^{117}In, ^{199}Hg, and ^{204}Pb were used to determine a total of fifty quadrupole coupling constants in insulators, including twenty with nonzero asymmetry parameters, which give oscillatory but aperiodic correlation functions. It was strikingly (and exhaustively) demonstrated that good determinations of quadrupole coupling constants could be made following isomeric transitions (IT) (with no elemental transmutation) and beta decay (with elemental transmutation). However, in no case was it possible to derive a coupling constant from a gamma-ray cascade preceded directly by electron-capture (EC) decay, presumably because the sudden creation of a K-hole, and the Auger and "shake-off" events that follow, destroy the chemical integrity of the species under study. Relaxation times were determined for a number of liquid samples. Studies of dimethyl-^{111m}Cd in various buffer gases showed that the spin memory was lost in one collision with heavy molecules, but that light molecules required several collisions. (auth)

16077 EFFECTS OF TEMPERATURE ON THE ENERGY OF THE 6.2-KEV MÖSSBAUER γ RAYS OF ^{181}TA. Kaindl, G.; Salomon, D. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 30: No. 13, 579-581 (26 Mar 1973).

We have found a strong temperature dependence of the energy of the 6.2-keV γ rays from dilute impurities of ^{181}Ta in transition-metal hosts. The observed temperature shifts cover a range of -32 to +8 times the expected thermal red shift, and exhibit large variations with the hosts. (auth)

16078 DWELL TIMES OF THIN EXPLODING WIRES. Vlastós, Antonios E. (The Royal Institute of Technology, S-100 44 Stockholm 70, Sweden). J. Appl. Phys. 44: No. 5, 2193-2196 (May 1973).

Equations describing the dependence of the dwell times on the applied voltage of thin exploding wires whose restrikes are initiated at the exterior or the interior of the exploded wire are derived, using the energy equation for the ionized gas surrounding the wire and the Paschen law for the sparking potential, respectively. A comparison of the computed and the experimentally obtained dependences of dwell times on the applied voltage was made for thin constantan and tungsten wires. (auth)

16079 ELECTRICAL AND MAGNETIC PROPERTIES OF SOME CUBIC INTERMETALLIC COMPOUNDS OF PLUTONIUM WITH Ru, Rh, Ir, Pd, AND Pt. Harvey, A. R.; Brodsky, M. B.; Nellis, W. J. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. B 7: No. 9, 4137-4142 (1 May 1973).

The electrical resistivities and magnetic susceptibilities of the cubic intermetallic compounds of the form PuX_2 (X=Ru, Rh, Ir, Pt) and PuX_3 (X=Rh, Pd, Pt) have been measured from 2 to 300 °K. The PuX_3 compounds order antiferromagnetically with Néel temperatures T_N of 6.6, 24, and 40 °K, respectively. The resistivities of the PuX_3 compounds decrease rapidly below T_N, and there is also an abrupt change in the slope of the resistivity-versus-temperature curve at T_N in $PuRh_3$. $PuPt_2$ orders ferromagnetically at a Curie temperature of $T_C = (6.0 \pm 0.3)$ °K, and the resistivity falls dramatically below T_C. $PuRh_2$ has a temperature-dependent susceptibility but there is no evidence for magnetic order, while the susceptibilites of $PuRu_2$ and $PuIr_2$ are temperature independent. However, the resistivities of $PuRh_2$, $PuRu_2$, and $PuIr_2$ have anomalous negative curvature at high temperatures, although the slopes remain positive throughout the temperature range investigated. The results are discussed in terms of the interatomic distance between plutonium atoms and the localized-spin-fluctuation model. (auth)

16080 ELECTRICAL AND STRUCTURAL PROPERTIES OF AMORPHOUS METAL-METAL-OXIDE SYSTEMS. Hauser, J. J. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. B 7: No. 9, 4099-4111 (1 May 1973).

Amorphous mixtures of Al-Al_2O_3, Sn-SnO_2, Ta-Ta_2O_5, and Ni-NiO were sputtered in various concentrations at room temperature. The resistivity was measured as a function of temperature between 1 and 300 °K in three different ways: two-point and four-point contacts in a planar geometry and in a capacitance configuration. The most extensive measurements conducted on the Al-Al_2O_3 and Sn-SnO_2 systems showed that, over nine orders of magnitude in resistance, the resistivity could be described by $\rho = \rho_0 e^{(T_0/T)^{1/n}}$ with $n = 4$ over a wide range of compositions in the Al-Al_2O_3 system. This resistivity behavior, along with the voltage dependence of the current and the ac resistivity measurements, indicate that the conduction mechanism in such films may be similar to the thermally activated hopping mechanism described in other amorphous materials. (auth)

16081 OPTICAL PROPERTIES OF SINGLE-CRYSTAL Be FROM 0.12 TO 4.5 EV. Weaver, J. H.; Lynch, D. W.; Rosei, R. (Ames Laboratory-USAEC and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. B 7: No. 8, 3537-3541 (15 Apr 1973).

Measurements of the optical absorptivity of single crystals of Be have been carried out in the energy range 0.12-4.5 eV with polarized light. The infrared absorptivity is considerably lower than previously reported. Evidence is presented for the onset of interband transitions for both polarizations beginning near 0.4 eV. A shoulder is noted in the absorptivity for $E \perp c$ at about 1.3 eV. The absorptivity data are Kramers-Kronig analyzed and the optical constants are determined. An interpretation based on the band structure of Tripp, Everett, Gordon, and Stark is presented. (auth)

16082 DENSITIES OF UNFILLED ONE-ELECTRON LEVELS IN THE ELEMENTS VANADIUM AND IRON THROUGH ZINC BY MEANS OF X-RAY CONTINUUM ISOCHROMATS. Turtle, Robert R. (Physics Department, University of Tennessee, Knoxville, Tennessee 37916); Liefeld, Robert J. Phys. Rev. B 7: No. 8, 3411-3419 (15 Apr 1973).

X-ray continuum isochromats have been obtained at a photon energy of 530 eV from bulk samples of vanadium, iron, cobalt, nickel, copper, and zinc under ultrahigh-vacuum conditions. The isochromats have been partially corrected for the smearing due to the spectral window of the two-crystal potassium acid phthalate (KAP) monochromator used and for the distortion due to the nonsingular nature of the electron spectra in the samples. The corrected data may be interpreted as measures of the densities of available one-electron states in these materials. (auth)

16083 CONTROL OF RESISTIVITY, MICROSTRUCTURE, AND STRESS IN ELECTRON BEAM EVAPORATED TUNGSTEN FILMS. Sinha, A. K.; Smith, T. E.; Sheng, T. T.; Axelrod, N. N. (Bell Telephone Laboratories, Incorporated, Murray Hill, New Jersey 07974). J. Vac. Sci. Technol. 10: No. 3, 436-444 (May 1973).

We have investigated the capability of the electron beam evaporation technique for producing thin W films having properties suitable for application as first-level metallization in refractory MOS (RMOS) devices. The apparatus consisted of a sputter-ion pumped 18-in. diam UHV station, 6-kW e gun, and a quartz crystal rate monitor. The evaporation process employs low background pressures ($1 - 3 \times 10^{-7}$ Torr), substrate heating (200-700 °C), a preevaporation step, and evaporation at rates of 100-500 Å/min. Maximum throughput is 16 1(1/4) -in. diam silicon slices per run. Using substrate temperatures of 500-700 °C, we have been able to produce mechanically stable, adherent films having a resistivity of 7-8 $\mu\Omega$ cm and a sheet resistance of $\simeq$ 0.08 Ω/* (for 9000-Å film). "Cold"-deposited films (> 1000 Å thick) having a high resistivity of 40-50 $\mu\Omega$ cm can be annealed at 1000 °C to resistivity of 10-15 $\mu\Omega$ cm. The films are single-phase bcc W with a small grain size of 0.1-0.2 μ. Low resistivity films (deposited above 550 °C) are associated with a large degree of microstructural perfection, and have small tensile stresses ($3\text{-}7 \times 10^9$ dyn cm^{-2}). The films possess excellent high-resolution etchability, and were found to be compatible with MOS structures provided care is exercised during the deposition. (auth)

16084 SURFACE DIFFUSION AND CLUSTER BINDING ENERGY OF INDIVIDUAL ATOMS ON TUNGSTEN SURFACES. Tsong, T. T. (Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802). Phys. Rev. B 7: No. 8, 4018-4020 (15 Apr 1973).

Some of the field-ion-microscopy data reported earlier are reinterpreted according to the comments given by Johnson and White. Their comments are either clarified or extended. The surprising result of the new interpretation is the exceedingly low binding energies of clusters. (auth)

16085 TEMPERATURE DEPENDENCE OF THE HALL EFFECT AND RESISTIVITY IN SINGLE CRYSTALS OF Mo AND Nb AND OF Mo-RICH-Re, Mo-Nb, AND Nb-RICH-Zr ALLOYS. Cox, W. Royall; Hayes, D. J.; Brotzen, F. R. (Rice

University, Houston, Texas 77001). Phys. Rev. B 7: No. 8, 3580-3588 (15 Apr 1973).

The Hall coefficients and resistivities of oriented single crystals of pure Mo and Nb and of an extended series of Mo–rich–Re, Mo–Nb, and Nb–rich–Zr alloy cystals were measured as a function of temperature between 295 and 4.2 K. The Hall coefficient R varies with composition roughly as the reciprocal of the density of states at the Fermi level, exhibiting a large peak at about 5.8 outer electrons per atom. Sharp dips occur in R for Mo and Nb between 20 and 40 K, which for the higher–purity Mo crystals are quite sensitive to the orientation of the magnetic field relative to the crystallographic axes. The temperature dependences of R for the alloy crystals suggest that impurity scattering is more anisotropic than phonon scattering in Mo–Nb and Nb–rich Zr but less anisotropic than scattering by phonons in Mo–rich Re. A quantitative measure of the magnitudes of these anisotropies is obtained from a two–band analysis of the Mo–rich–sample using the rigid–band aproximation in conjuction with calculated energy surfaces. (auth)

16086 MÖSSBAUER EFFECT IN DY^{161} IN MOLYBDENUM. Cohen, R. L. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. Lett. 30: No. 16, 727-729 (16 Apr 1973).

The effects of paramagnetic hyperfine structure can be used to explain the recoil-free fraction "anomaly" recently reported for Dy^{161} in molybdenum. (auth)

Radiation Effects

Refer also to abstracts 15238, 15905, 17023, 17376, 17420, 17422, 17441, and 17620.

16087 (NIIAR-P-136) MECHANISM OF FISSION-FRAGMENT YIELD FROM CERAMIC NUCLEAR FUEL. Samsonov, B. V.; Frei, A. K. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 22p. (In Russian). INIS.

Data on the yield of gaseous fission fragments from ceramic nuclear fuel were used to formulate a mechanism of migration of these fragments within the crystalline structure of the grain of the fuel. Point defects arose in the fuel grain structure with the onset of irradiation (10^5 I/fission). Annealing of the defects and their union into free pores are discussed. Free pores also arise which are capable of being annealed with a given probability. Entrapped atoms of gaseous fission fragments are transformed into gas bubbles, possessing a small degree of mobility. (tr-auth)

16088 (ORNL-4871) RADIATION STRENGTHENING AND EMBRITTLEMENT IN HEAVY-SECTION STEEL PLATES AND WELDS. Stelzman, W. J.; Berggren, R. G. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 57p. Dep. NTIS $5.45.

Fast-neutron-induced changes in the mechanical properties of two 12-in.-thick A533-B, class 1 steel plates and a matching submerged-arc weldment and an electroslag weld in a $6\frac{3}{8}$-in.-thick SA302-B (code case 1339) steel are presented. Postirradiation increases of strength and notch-impact transition temperature and decrease in ductility were determined for several irradiation temperatures. Observations using data obtained from an instrumented Charpy testing machine are also given. (auth)

16089 INFLUENCE OF RECRYSTALLIZATION ON THE HIGH-TEMPERATURE EMBRITTLEMENT OF AUSTENITIC STAINLESS STEEL INDUCED BY α IRRADIATION. Furuta, T.; Kawasaki, S. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 47: No. 1, 102-104(May 1973).

Helium embrittlement was studied in He-injected Type-316 stainless steels with equal recrystallized grain size. The content of injected He was 7.5×10^{-6} atomic fraction for all samples, and heat treatments were varied to obtain equal grade sizes recrystallized before and after He injection. Tensile properties were measured at 500, 650, and 750°C. Elongations of the samples recrystallized at 900°C and then injected with He are larger than those of the samples first injected with He and recrystallized at 1000°C. (DLC)

16090 HYDROGEN IN PROTON-IRRADIATED TYPE-316 STAINLESS STEEL AND TANTALUM. Keefer, D. W.; Pard, A. G. (Atomics International, Canoga Park, CA). AT(04-3)-824. J. Nucl. Mater.; 47: No. 1, 97-101(May 1973).

Experiments were made to detect any association between voids and hydrogen introduced during proton irradiation. An ion microprobe mass analyzer was used for the hydrogen analyses. Results for a sample injected with He at room temperature and irradiated at 500°C to 1.3×10^{19} protons/cm^2 show that the H content is constant throughout the sample thickness. An H profile determined for a Ta sample which was irradiated at 700°C with 7.4×10^{19} protons/cm^2, also showed no evidence of H entrapment in voids. It is concluded that the nucleation and growth of voids in proton-irradiated Type 316 stainless steel and Ta are unaffected by the deposition of hydrogen during irradiation. (DLC)

16091 EFFECT OF TEMPERATURE AND NEUTRON IRRADIATION UPON THE FATIGUE-CRACK PROPAGATION BEHAVIOR OF ASTM A533-B STEEL. James, L. A.; Williams, J. A. (Westinghouse Hanford Co., Richland, WA). Contract AT(45-1)-2170. J. Nucl. Mater.; 47: No. 1, 17-22(May 1973).

The fatigue-crack propagation behavior of A533-B steel was studied within the framework of linear-elastic fracture mechanics. Tests were conducted at 24°C and 288°C on unirradiated material, and on material irradiated at 288°C to $2.3-2.8 \times 10^{19}$ n/cm^2 and $5.3-5.7 \times 10^{19}$ n/cm^2 (E > 1 MeV). In general, at the cyclic frequency used (600 cpm), neither temperature nor neutron irradiation had a significant effect on the fatigue-crack propagation. (5 figures) (auth)

16092 EFFECT OF COLD WORKING ON CREEP-RUPTURE PROPERTIES FOR HELIUM-INJECTED AUSTENITIC STAINLESS STEEL. Furuta, T.; Kawasaki, S.; Nagasaki, R. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 47: No. 1, 65-71 (May 1973).

In order to study the effect of helium on the high-temperature embrittlement of stainless steel, helium (7.5×10^{-6} atomic fraction) was injected into cold-worked stainless steels by using a cyclotron. At 650°C, it appeared that the reduction in creep-rupture strength due to helium was larger as cold working was increased, but a loss of rupture elongation was less for a particular degree of cold working. The 10% cold-worked material showed particularly good creep-rupture properties in the presence of helium. The loss of ductility was more pronounced in the creep test than in the tensile test. (9 figures) (auth)

16093 EFFECT OF INTENSE REACTOR RADIATION ON THE SHEAR MODULUS AND INTERNAL FRICTION OF IRON. Grinik, E. U.; Efimov, A. I.; Karasev, V. S.; Landsman, V. S.; Paliokha, M. I. At. Energ. (USSR); 34: No. 5, 397-399(May 1973). (In Russian).

The shear modulus and internal friction of Fe were measured after exposure to integral fluxes of $\sim 2.2 \times 10^{20}$ neutrons/cm^2 (E $\geq$ 0.1 MeV) at a level of intensity of $\sim 10^{14}$ neutrons/cm^2/sec. Changes in the internal friction and in the shear modulus were associated with an increase in the concentration of point defects as a result of irradiation. (KSW)

16094 FRANK-LOOP DEVELOPMENT IN NEUTRON-IRRADIATED COLD-WORKED TYPE-316 STAINLESS STEEL. Brager, H. R.; Straalsund, J. L. (Westinghouse Hanford Co., Richland, WA). Contract AT(45-1)-2170. J. Nucl. Mater.; 47: No. 1, 105-109(May 1973).

Results presented show that neutron irradiation (fluence = 0.6×10^{22} n/cm^2) of 20% cold-worked steel at ~450°C induces the replacement of nearly the entire dislocation network with interstitial Frank loops. A solution-treated sample of the same steel, irradiated under identical conditions, had voids and interstitial Frank loops, indicating that Frank loop formation is not strongly dependent on defect sink (dislocation) density. (DLC)

16095 COMPUTER SIMULATION OF SPUTTERING. Part 2. Harrison, D. E. Jr.; Moore, W. L. Jr.; Holcombe, H. T. (Naval Postgraduate School, Monterey, CA). Radiat. Eff.; 17: No. 3-4, 167-183(1973).

Conclusions of Pt. 1 were confirmed by simulations in which the copper target is represented by a composite potential function consisting of a Born–Mayer repulsive potential segment, a cubic potential matching segment, and a Morse potential attractive segment. Surface-layer relaxation was included, and surface-layer atom binding energies for the most primitive planes of copper were determined to be: $E_b(100) = 2.4 \pm 0.1$ eV, $E_b(110) = 2.1 \pm 0.1$ eV, and $E_b(111) = 2.4 \pm 0.1$ eV. For argon sputtering of copper, there is no detectable change in the spot patterns between the two models, and the sputtering yields agree. Sputtering yield vs energy curves now agree quite closely with the experimental data. For sputtering at 5 keV, the energy distribution of the sputtered atoms has the form $dN/dE \sim E^{-1.4}$. The argon/copper sputtering efficiency matches the polycrystalline experimental data of H. H. Andersen. Oblique ion incidence simulations on the (100) copper surface are compared with the 5-keV data of Southern, Willis, and Robinson, and with the 20-keV data from the Amsterdam group. The simulations indicate fine structure in the yield vs angle of rotation curves. Well-defined peaks with widths less than one degree were identified at points on the curve where expected. The simulations exhibit a fine structure anomaly that may explain the "cloudy region" experimental anomaly in the neon/copper system. Simulations at 20 keV succeeded in producing focuson sputtering from a sixth atomic layer primary collision. These focuson events occur with very low probability. High-energy

(>10 keV) oblique incidence sputtering was simulated as a two-stage process. In the first stage, energy is deposited in primary knock-on atoms at various depth below the crystal surface. The second stage is a yield per primary knock-on atom as a function of depth, energy, and direction of recoil. Except for ⟨110⟩ direction recoils, the recoil atom collision mechanism is characteristically a cascade rather than a collection of focusons. (UK)

16096 DISLOCATION VIBRATION AS A POSSIBLE CURE FOR HIGH-TEMPERATURE VOID FORMATION IN METALS UNDER FAST-NEUTRON IRRADIATION. Green, W. V.; Weertman, J. (Los Alamos Scientific Lab., NM). Nature (London); 243: No. 5403, 159-160(18 May 1973).

Extensive void formation occurs in metals subjected to fast neutron irradiation in the temperature range 0.3 to 0.5 T_m, where T_m is the melting temperature of the metal. This is a serious problem in reactor technology. It is pointed out that if a dislocation can be made as efficient (or more efficient) a sink for vacancies as for interstitials, void growth will be prevented, and it is here indicated how this may be done by forcing dislocations to vibrate under cyclic stresses. Applications to stainless steel are discussed. (UK)

16097 SOME THEORETICAL ASPECTS OF THE EVOLUTION OF RADIATION DEFECTS IN SOLIDS. Nguyen Van Doan; Adda, Y. (CEN de Saclay, Gif-sur-Yvette, France). J. Microscop.; 16: No. 2, 125-156(1973). (In French).

From annual meeting of the French Society of Electron Microscopy; Nantes, France (29 May 1972).

Various theoretical considerations concerning the behavior of radiation defects from the moment of their creation up until their elimination and precipitation are discussed, together with the macroscopic effects which are of interest in nuclear metallurgy. (164 references) (FR)

16098 REACTOR MATERIALS PERFORMANCE. Proceedings of an ANS Topical Meeting, Richland, Washington, April 23–26, 1972. Nucl. Technol.; 16: No. 1, 1-354(Oct 1972). (CONF-720420--).

The twenty-nine papers included were presented in five sessions on radiation effects on fuel pin cladding, fuel performance, absorber materials, coolants, and structural materials. A separate abstract was prepared for each of the 29 papers. (DLC)

For abstracts of individual papers see: 15905–15915, 15971, 15972, 16048–16050, 16099–16108, 17394, 17441, and 17620.

16099 DAMAGE FUNCTION ANALYSIS OF AUSTENITIC-STEEL NEUTRON-INDUCED MECHANICAL PROPERTY CHANGE DATA. Simons, R. L.; McElroy, W. N.; Blackburn, L. D. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 14-24(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Damage functions were determined for Type-304 stainless-steel mechanical property changes in yield strength and total elongation for an irradiation and test temperature of ~480°C. The damage functions correlate the spectral effect of test-reactor neutron-induced changes in mechanical properties for subsequent use in predicting fluence limits for specified property level changes for reactor design studies. By propagating errors in the damage function analysis, a conservative lower bound fluence limit may be estimated. Results show that the yield-strength damage function is nearly the same as the displacement cross section used as the first approximation to the damage function. The total elongation damage function shows a high-energy (>4 MeV) and low-energy ($<10^{-3}$ MeV) enhancement of damage. Consequently, it is necessary to consider neutrons of all energies when correlating both fast and thermal test reactor data. (5 tables, 6 figures, 28 references) (auth)

16100 SCIM: A THEORY-BASED COMPUTER CODE FOR PREDICTION OF IN-PILE BEHAVIOR OF TYPE 304 STAINLESS STEEL. Harkness, S. D.; Grappel, R.; McDonald, S. G. (Argonne National Lab., IL). Nucl. Technol.; 16: No. 1, 25-35(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

A model for the behavior of Type-304 stainless steel during high-temperature fast-reactor irradiation was developed into the computer program SCIM (Swelling and Creep of Irradiated Metals). Swelling rates are discussed in terms of the relative efficiences of voids and dislocations as sinks. The swelling rate is at maximum when the sink efficiencies are equal. The dose dependence of swelling is found to be a function of the relative rates of void and dislocation loop formation. Saturation mechanisms are discussed with respect to their effect on the swelling rate. Saturation is favored by increased void number density and increased irradiation temperature. This results in a compromise between irradiation temperature and the expected void volume at saturation. At 372°C, the dose dependence of swelling in cold-worked material is expected to be much higher than for solution-annealed material because of the rapidly changing relative effectiveness of voids and dislocations as point-defect sinks. High number densities of incoherent precipitate should limit swelling at intermediate irradiation temperatures by forming a saturation microstructure at low void volumes. A climb-controlled in-pipe creep mechanism was developed. The expression that results depends on the radiation-produced excess interstitial flux to glissile dislocations as the mechanism for enhanced in-pile creep. The glissile dislocations are created by the unfaulting of irradiation-produced interstitial dislocation loops. The principal obstacle is taken as dislocations pinned by the void structure. The maximum in-pile creep rate is expected to occur at nearly the same temperature at which swelling is a maximum. The creep rate is expected to decrease slowly with dose. (8 figures, 3 tables) (auth)

16101 ANALYSIS OF THE EFFECTS OF HYDROSTATIC STRESS ON SWELLING. Straalsund, J. L.; Guthrie, G. L. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 36-44(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The effects of hydrostatic stress on void growth during irradiation was studied using a diffusion model similar to that developed by Bullough and Perrin. Pressure effects were introduced into the theory via the boundary values assigned to the vacancy and interstitial concentrations in close proximity to voids and dislocations. General conclusions of the analysis were: (1) At irradiation temperatures equivalent to the maximum swelling rate and above, the void growth rate increases linearly with hydrostatic tensile stress. Using estimated parameters for stainless steels, no effect was found for temperatures below about 450°C. (2) For constant structure, the stress effect was found to have the temperature dependence associated with self-diffusion. (3) The stress effect may be recognized as a form of Nabarro Herring creep and is therefore independent of damage rate. Stress effects could thus, in principle, be measured during postirradiation annealing experiments. Because of the uncertainties associated with many of the parameters incorporated in the swelling model, it was not possible to provide a reliable quantitative description of the effects of stress. (6 figures, 21 references) (auth)

16102 EFFECT OF NEUTRON IRRADIATION ON THE DUCTILITY OF AUSTENITIC STAINLESS STEEL. Bloom, E. E.; Weir, J. R. Jr. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 1, 45-54(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The effects of fast neutron irradiation on the tensile and creep-rupture ductility of austenitic stainless steels are presented. At low temperatures, below 450°C, radiation causes a reduction in the strain hardening exponent and thus the uniform strain. At high temperatures, above 750°C, reduced ductility results from helium embrittlement. At intermediate temperatures, hardening and helium effects act synergistically to produce lower ductility than would result from either effect alone. (7 figures, 21 references) (auth)

16103 INTERRELATIONSHIP BETWEEN SWELLING AND IRRADIATION CREEP. Wolfer, W. G.; Foster, J. P.; Garner, F. A. (Westinghouse Electric Corp., Madison, PA). Nucl. Technol.; 16: No. 1, 55-63(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The dimensional changes occurring in metals under fast-neutron irradiation and external loads were analyzed in terms of dislocation climb and glide, dislocation loop formation, and diffusional growth of voids. The strains produced by these mechanisms were derived. Although these strains can be divided into swelling strains and creep strains, the irradiation creep strains may be related to the swelling strains. Strains produced by the climb of dislocations contribute mainly to swelling, but not to irradiation creep. However, if the glide of dislocations is controlled by the climb motion, the resulting irradiation creep rate is directly proportional to the swelling rate. Preferential loop nucleation induced by external stresses gives rise to an irradiation creep correlation which is in agreement with the experimental data. (30 references) (auth)

16104 EVALUATION OF THE EFFECT OF INTERGRANULAR ATTACK ON FUEL PIN BURST PROPERTIES. Ring, P. J.; Challenger, K. D.; Busboom, H. J. (General Electric Co., San Jose, CA). Nucl. Technol.; 16: No. 1, 64-74(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Burst rupture tests were carried out on irradiated fuel pin cladding to determine the effect of intergranular attack on burst

rupture strength and ductility and so to assess the ability of the weakened cladding to withstand power surge or loss of coolant conditions. Results indicate that the burst rupture strength or yield strength is not drastically reduced by localized attack extending through as much as 35% of the cladding thickness. Ductility values, however, do appear to be substantially reduced. In terms of reactor operation, this suggests that in a transient stress situation the cladding would be able to withstand higher stresses than previously predicted using a wall thinning criteria, based on the maximum depth of cladding attack, but would tolerate far less deformation than unattacked cladding before failure. (8 figures) (auth)

16105 FUEL-CLADDING MECHANICAL INTERACTION IN LMFBR FUEL RODS. Rubin, B. F.; Black, T. J.; Appleby, W. K.; Stephen, J. D.; Hilbert, R. F. (General Electric Co., San Jose, CA). Nucl. Technol.; 16: No. 1, 89-99(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Experimental determinations of cladding plastic deformation in $(U,Pu)O_2$ fuel rods, clad with annealed Type 316 stainless steel and irradiated in EBR-II, indicate that fuel–cladding mechanical interaction takes place between ~3 and 8 at.% burnup. At higher burnups, the cladding swelling rate increases markedly resulting in no further fuel-induced plastic deformation. The maximum cladding plastic strain exhibited by several annealed Type 316 stainless-steel-clad rods was 0.4%. Cladding plastic strain was found to be independent of smeared density in the range of 83 to 91% TD. (9 figures) (auth)

16106 ESTIMATES OF CREEP–FATIGUE INTERACTION IN IRRADIATED AND UNIRRADIATED AUSTENITIC STAINLESS STEELS. Brinkman, C. R.; Korth, G. E.; Hobbins, R. R. (Aerojet Nuclear Co., Idaho Falls, ID). Nucl. Technol.; 16: No. 1, 297-307(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Comparing data obtained from tests conducted on unirradiated Type 316 stainless steel in either the solution-annealed or solution-annealed-and-aged condition showed that aging was beneficial in improving both the fatigue and creep–fatigue properties at 593°C. An indication was found that unirradiated Type 304 stainless steel would be more suitable for applications involving creep–fatigue interaction than unirradiated Type 316 stainless steel. Irradiation to fluences of 0.17 to 6.1×10^{21} n/cm^2 E > 0.1 MeV (450°C), resulted in a pronounced effect on the creep–fatigue resistance of these materials when tested at a strain range of 1%. Both fatigue and creep damage values were calculated using actual times and cycles to failure and design times and cyles to failure. These damage values were summed linearly. Damage sums obtained were not found to be a unique value but dependent upon strain range, length of tensile hold time, and material condition. Comparisons between estimates of irradiated fatigue behavior and actual irradiated fatigue lifetimes were made using limited data available. Estimates made using irradiated tensile data were usually found to be conservative in predicting pure-fatigue behavior. (6 figures, 4 tables, 17 references) (auth)

16107 EFFECT OF IRRADIATION ON THE STRAIN RATE DEPENDENCE OF TYPE 304 STAINLESS-STEEL MECHANICAL PROPERTIES. Steichen, J. M. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 308-315(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

High strain rate tensile data were obtained on Type 304 stainless steel which was irradiated in EBR-II to a maximum fluence of 0.7×10^{22} n/cm^2 (E > 0.1 MeV) at a temperature of ~950°F. Tests were performed over a range of strain rates from 3×10^{-5} to 1×10^{1} s^{-1} at 800 and 1000°F to provide mechanical properties information for safety analyses for the Fast Flux Test Facility. Results demonstrate that the strength of irradiated Type 304 stainless steel remains essentially constant with increasing strain rate and the ductility decreases with strain rate at a fluence of 0.2×10^{22} n/cm^2 and increases with strain rate at a fluence of 0.7×10^{22} n/cm^2. (8 figures) (auth)

16108 POST-IRRADIATION CREEP OF ANNEALED TYPE 316 STAINLESS STEEL. Lovell, A. J. (Westinghouse Hanford Co., Richland, WA). Nucl. Technol.; 16: No. 1, 323-331(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The effects of fast-reactor irradiation on the creep behavior of annealed Type 316 stainless steel were reviewed, and the interrelation between creep response and irradiation-induced microstructure development was analyzed. The effects of neutron fluence, irradiation temperature, and test temperature on creep response were studied using illustrative examples. The results indicate that use of creep data from unirradiated specimens for design purposes overestimates strain expected during irradiation, except when a component is stressed at low temperature following high-temperature irradiation. (12 figures, 14 references) (auth)

16109 NOTCH TOUGHNESS OF AUSTENITIC STAINLESS STEEL WELDMENTS WITH NUCLEAR IRRADIATION. HAWTHORNE: J. R.; Watson, H. E. (Naval Research Lab., Washington, DC). Weld. J. (N.Y.); 52: No. 6, 255s-260s(Jun 1973).

The pre- and postirradiation notch toughness of austenitic stainless steel plates and weld deposits was explored to aid materials selection and application for liquid metal fast breeder (LMFBR) reactors. The study encompassed six plates (AISI Types 304, 316, 304L, 316L), two submerged arc weld deposits (Types 308 and 316), and one shielded metal-arc weld deposit (Type 308). Dynamic tear (DT) and Charpy-V (C_v) test methods were employed to determine notch toughness trends. Specimen irradiations were conducted in the EBR-II reactor in sodium at temperatures from 700 to 840°F. Neutron fluences ranged from 1 to 12×10^{21} n/cm^2 >0.1 MeV. Significant radiation reductions in notch toughness were observed for both weld deposit and plate materials. Postirradiation toughness of weld deposits in general appeared to be inferior to that of base metals. A postirradiation C_v energy level of less than 20 ft-lb and a postirradiation DT energy level of approximately 250 ft-lb were observed for one Type 308 weld deposit. Comparisons indicate significantly greater DT notch toughness for welds produced by the shielded metal-arc method than by the submerged arc method. Delta ferrite content as well as composition are viewed as critical factors in postirradiation behavior. The DT and C_v performance of plate and weld deposits were found relatively independent of postirradiation test temperature for the range 75 to 900°F but were noticeably higher at 1100°F. All weldments gave evidence of notch toughness degradation with 1000 h thermal aging at 900°F. (auth)

16110 UNSTABLE EQUILIBRIUM AND RADIATION DEFECTS IN SOLIDS. Koshkin, V. M. (Inst. of Monocrystallography, Kharkov); Gal'chinetskii, L. P.; Kulik, V. N.; Minkov, B. I.; Ulmanis, U. A. Solid State Commun.; 13: No. 1, 1-4(1 Jul 1973).

A new type of point defect in solids genetically related with Frenkel's pairs appears when there exists the instability zone of pair vacancy (v)–interstitial atom (i). It is shown that, at large instability zones typical of loose crystalline structures, equilibrium concentration of unstable pairs i–v may exceed the concentration of usual Frenkel's pairs. In the example of the semiconducting crystals In_2Te_3 and Ga_2Te_3, having loose structure, it is experimentally demonstrated that equilibrium point defects cannot be preserved by specimen quenching and that irradiation by large doses of high-energy particles does not result in stable radiation defects formation. (auth)

16111 DIFFRACTION FROM VOID AND BUBBLE ARRAYS IN IRRADIATED MOLYBDENUM. Sass, S. L.; Eyre, B. L. (United Kingdom Atomic Energy Research Authority, Harwell, Eng.). Phil. Mag.; 27: No. 6, 1447-1453(Jun 1973).

Electron-diffraction patterns from irradiated molybdenum and TZM specimens containing periodic arrays of voids or helium gas bubbles were studied. It was demonstrated that the void or bubble arrays act as diffraction gratings and produce extra reflections centered around the molybdenum matrix reflections. This technique enables a rapid evaluation to be made of the average void lattice parameter, and it is shown to be particularly useful for the study of arrays where spacing measurements are not feasible from micrographs of the direct images. It is pointed out that an important potential application of the technique is for study of ordered arrays of submicroscopic defects. (auth)

16112 INTERPRETATION OF LEDGE BRIGHT SPOT CONTRAST EFFECTS IN FIELD ION MICROSCOPE IMAGES. Robinson, J. T.; Wilson, K. L.; Seidman, D. N. (Cornell Univ., Ithaca, NY). Phil. Mag.; 27: No. 6, 1417-1432(Jun 1973).

A detailed pulse field evaporation study was made of the field evaporation characteristics of atoms from the first five ledges of (011) planes of high purity ($\leq 1.5 \times 10^{-6}$ at.fr. impurity level) tungsten of well-annealed specimens and specimens irradiated with 35- or 40-keV W^+ ions at room temperature (middle of Stage II) in vacua of ~10^{-6} torr. The detailed examination of >1.8×10^4 frames of cine film of the well-annealed control specimens and >2.6×10^4 frames of film of the irradiated specimens showed that the bright spots identified by Buswell (Buswell, J. T., Phil. Mag., 1971, 23, 293) as vacancies decorated by surface contamination, were in reality normal tungsten atoms associated with the ledges of (011) planes. The identification of these bright spots as tungsten ledge atoms was achieved by employing a field evaporation increment of 2.5×10^{-3} of an (011) plane per evaporation pulse. The concentrations of ledge bright spots in the control and in the irradiated specimens were almost identical. The vacancy concentrations, as measured in seven different families of high-index planes [(111), (233), (122), (133), (433), (342), and (543)]

changed by a factor of 10^2 as a result of the irradiation. Hence, it was concluded that Buswell's model for the bright spots in the ledges of (011) plane is incorrect. An example was given of the field evaporation of a small vacancy cluster in an (011) terrace plane which gave rise to a double ledge bright spot contrast effect. A hard sphere ball model of a cluster of three vacancies in an (011) terrace showed that these ledge bright spots were the byproduct of the field evaporation process. Thus, this special type of contrast effect must be taken into account when analyzing cine film of irradiated specimens. The existence of the phenomenon of ledge bright spots does not affect our prior interpretation of self-interstitial atoms as also causing bright spot contrast, as the two effects are readily distinguishable from one another. (auth)

16113 EXPERIMENTAL METHOD FOR DETERMINING THE DISLOCATION LOOP NUCLEUS SIZE. Leteurtre, J.; Pouchou, J. L.; Zuppiroli, L. (CEN, Fontenay-aux-Roses, France). Phil. Mag.; 27: No. 6, 1323-1334(Jun 1973). (In French).

The principles of an experimental method for determining the dislocation loop nucleus size are described. The basic experiment for this method consists in measuring the dimensional changes of a single crystal irradiated under a uni-axial stress. By favoring some Burgers vectors to the detriment of others, the stress induces some artificial anisotropy which is directly related to the nucleation process. More precisely, the induced-growth coefficient measuring this anisotropy is shown to depend strictly on the vacancy and interstitial nuclei sizes. The statistical hypothesis which leads to this result is discussed. Finally, it is shown that the extra stresses induced by the grown-up dislocation loops on a nucleating loop have no influence on the measured dimensional changes. (auth)

16114 PLASMON COHESIVE ENERGY OF VOIDS AND VOID LATTICES IN IRRADIATED METALS. Lucas, A. A. (Surface Physics Division, European Space Research Organisation, Noordwijk, Holland). Phys. Rev. B 7: No. 8, 3527-3537 (15 Apr 1973).

The contribution of the long-range electron–Coulomb correlation to the surface energy of an empty spherical cavity in a metal is calculated from the zero-point energy of surface plasmons characteristic of the spherical void boundary. At large void radii one recovers the result previously derived for a planar metal–vacuum interface. Next it is shown that, owing to the overlapping of surface-plasmon zero-point oscillations around two neighboring voids, an effective attraction exists between them which is analogous to the van der Waals (dispersion) forces between small metal spheres in vacuum. However, because of the monopole nature of the fundamental surface-plasmon mode of a void, the effective void–void interaction is much stronger and of much longer range than the attraction of spherical particles for which the lowest-order plasmon mode is of dipole type only. It is therefore proposed that plasmons may be one of the important physical processes responsible for void nucleation and growth and also for the observed occurrence of three-dimensional void arrays in some heavily irradiated transition metals. In a void lattice, the plasmon modes of an isolated void split and broaden into bands. The resulting plasmon cohesive energy per void is estimated to be of the order of –1 eV for the observed bcc void array in molybdenum and –2.5 eV for the fcc nickel array. (auth)

Other Materials

Refer also to abstracts 15361, 15854, 15938, 15940, 15964, 16076, 16816, 17421, 17432, 17476, 17754, 17764, 17767, 17779, 17807, and 17820.

16115 (AERE-R-6062) STRUCTURE OF REACTOR GRAPHITES AND ITS EFFECT ON DIMENSIONAL STABILITY AT HIGH TEMPERATURES. Thrower, P. A. (Atomic Energy Research Establishment, Harwell (England)). Apr 1969. 55p. Dep. NTIS (U. S. Sales Only) $4.75.

Six reactor grade graphites were irradiated to ~10^{21} n/cm^{-2} at 900 and 1200°C and their dimensional changes measured. Interpretation of variations in behavior was made by examining the graphite structures by x-ray diffraction, transmission and replica electron microscopy, scanning electron microscopy, and chemical analysis. Four types of crystallite, not necessarily coexistent, were identified, two of which are tentatively associated with the binder phase. The defects produced in these components were also examined. Graphites heated to 3000°C for half an hour were similarly treated and examined. A model of defect nucleation involving c-axis diffusion of interstitials via nonbasal dislocations and loss of vacancies to crystallite edges is proposed to account for the observations. This indicates that dimensional stability improves with crystal perfection because of the lower density of nonbasal dislocations. A correlation between crystal perfection and dimensional stability was observed for irradiations at 900°C. An indication is given of the properties required of a reactor graphite for dimensional stability under high-temperature irradiation and these include a possible beneficial effect of adding small quantities of boron to fine-grain graphites. (auth)

16116 (ITEF-827) DEPENDENCE OF ANNEALING AND ACCUMULATION OF FISSION FRAGMENT-INDUCED DEFECTS IN GLASS ON THE DEPTH OF THEIR FORMATION. Gorshkov, V. K.; Petrov, P. A. (Gosudarstvennyi Komitet Po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 14p. (In Russian). INIS.

Rapid elimination of defects caused by fission fragments in the vicinity of a glass surface was observed during uniform heating of the sample. The concentration (or accumulation) of defects in the glass near the surface was extremely small, but it increased linearly with distance from the surface. The higher the annealing temperature the stronger the influence of the surface became on defect disappearance in the interior of the sample. The size of the defects grew with prolonged annealing. (tr-auth)

16117 (LA-5287-PR) RESEARCH ON CARBON AND GRAPHITE. Quarterly Progress Report, January 1–March 31, 1973. Imprescia, R. J.; Reiswig, R. D.; Williams, J. M.; Honnell, R. E. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 20p. Dep. NTIS $3.00.

The THF-soluble portion of a pyrene-base polyphenylene was primarily dimeric pyrene and had qualities of a good binder or impregnant: low softening point (80°C) and good yield (58 wt %) of highly crystalline carbon (L_c = 1260Å). Ironsides FF-17 phenolic resin, a possible impregnant, was very viscous (1.04×10^6 cP at 25°C) and apparently was a phenol-doped novalak containing an oxazoline crosslinking agent. Its viscosity-temperature behavior was normal, but its pyrolysis was unexpectedly violent. An acidic carbon black addition substantially increased the carbon yield from a coal-tar pitch. Presumably, the acidic surface sites couple the pitch molecules, which would normally vaporize before coking. Heating destroyed these sites and left the carbon alkaline. A density gradient of 1.71 to 1.83 g/cm^3 in a graphite specimen 3-in.-dia and 3-in.-long was essentially eliminated by five impregnation/heat-treatment cycles with a coal-tar pitch. Similar size specimens can be saturated at 200 psig in 1 hour with furfuryl alcohol resins having viscosities below 2300 cP. In equal time, 95% saturation occurs at 100 psig. Losses due to resin exuding from impregnated graphites during curing were eliminated by treating the specimens with hydrogen chloride before curing. This treatment apparently produces a varnish which seals the peripheral pores. Routes to improve RPP composite and carbon-reinforced aluminum composites are discussed and the most fruitful approaches for LASL to pursue are discussed. (auth)

16118 ACTINIDE PNICTIDES AND CHALCOGENIDES. 2. Tellurium Hyperfine Field in Uranium Monotelluride from Moessbauer Spectroscopy and Its Relation to the Uranium Ordered Moment. Longworth, G.; Wedgwood, F. A.; Kuznietz, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London); 6: No. 9, 1652-1660(10 May 1973).

Measurements are reported of the tellurium hyperfine field in uranium monotelluride (UTe) from ^{125}Te Mössbauer spectroscopy, and the uranium ordered magnetic moment in the same sample by neutron diffraction, as a function of temperature. The temperature dependence of the tellurium hyperfine field is essentially the same as that of the uranium ordered moment except close to the Curie temperature, $T_c = 108 \pm 3$ K, where effects due to short-range magnetic order may be present. The Mössbauer linewidths obtained are about 25% greater than the narrowest widths obtained with the ^{125}I (in Cu) source, probably due to the small nonstoichiometry in the sample. The isomer shift of UTe is $+0.24 \pm 0.05$ mm s^{-1} with respect to the source, and a value for the Debye temperature of about 160 K is obtained. The value of the tellurium saturation hyperfine field is 130 ± 5 kOe. The values of the anion hyperfine field in UTe and in the antiferromagnet USb are discussed in terms of the long-range nature of the magnetic exchange interactions in those compounds. (auth)

16119 ENERGY DEPENDENCE OF He^+ AND H^+ CHANNELING IN Si OVERLAID WITH Au FILMS. Lugujjo, E.; Mayer, J. W. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. B 7: No. 5, 1782-1791 (1 Mar 1973).

Channeling measurements by backscattering of He and H ions have been made on <111>- and <110>-oriented Si covered with evaporated layers of Au to investigate the dependence of minimum yield on both energy and film thickness. The energy range was 0.4–1.8 MeV and the film thickness range was 100–1100 Å. Minimum yields are calculated by applying the Meyer treatment of plural scattering and probability curves determined from (i) a step-function approximation to the angular yield

profile and (ii) two different axial scans on uncovered Si, one of which is azimuthally averaged. The minimum yields calculated using the step-function approximation and azimuthally averaged probability curves are in good agreement with experimental results. This suggests that the step-function approximation, although less accurate than the azimuthally averaged procedure, is adequate for use with investigations of disorder in crystals by channeling-effect measurements. (auth)

16120 ELECTRON SLOWING-DOWN SPECTRUM IN IRRADIATED SILICON. Emerson, L. C.; Birkhoff, R. D.; Anderson, V. E.; Ritchie, R. H. (Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. B 7: No. 5, 1798-1811 (1 Mar 1973).

An electron slowing-down flux spectrum has been measured for β particles, δ rays, and secondaries in neutron-activated silicon over the energy range from a few eV to 30 keV. The spectrum is found to be similar to slowing-down spectra generated in metals by β particles. Absolute agreement with predictions of the Spencer-Fano theory is found for energies above 10 keV. Experimental fluxes are somewhat larger for lower energies. A companion theoretical calculation has been carried out based on model cross sections for Si. These include the effects of plasmon creation and electron-hole pair production in the valence band and excitation of electrons from the K and L levels. The latter processes were described on the basis of sum-rule-corrected classical cross sections. Monte Carlo calculations of the slowing-down spectrum were made. The present theory, as well as an empirically shell-corrected Spencer-Attix theory, gives spectra which are smaller than experiment by a factor of $\approx$4 in the 10- to 100-eV range. (auth)

16121 SCINTILLATION RESPONSE OF NAI(TL) AND KI(TL) TO CHANNELED IONS. Altman, M. R.; Dietrich, H. B.; Murray, R. B. (Physics Department, University of Delaware, Newark, Delaware 19711); Rock, T. J. Phys. Rev. B 7: No. 5, 1743-1752 (1 Mar 1973).

The scintillation pulse-height response of NaI(Tl) and KI(Tl) to ^{4}He and ^{16}O ions in the 2-60-MeV range has been studied with the ion beam aligned along low-index planes and axes and also aligned along a random direction. The scintillation efficiency increases by as much as 50% when the ion beam is channeled along a major symmetry direction. The effect of channeling has been observed by recording the pulse-height spectra for monoenergetic ions oriented along {100}, {110}, and {111} planes, and along <100>, <110>, and <111> axes. The increase in pulse-height response is in semiquantitative agreement with recent model calculations. Observation of this effect permits study of channeling phenomena in thick crystals that are scintillators. In particular, this paper reports a measurement of the critical angle for channeling of 15-MeV ^{16}O along a {100} plane. (auth)

16122 RADIATION DAMAGE AND COLOR CENTERS IN ZnF_2 AND MgF_2. Butler, C. T. Stillwater, OK; Oklahoma State Univ. (1972). 105p. University Microfilms Order No. 73-15,063.

Thesis (Ph. D.).

The optical absorption resulting when ZnF_2 crystals were irradiated with 2-MeV electrons at temperatures from 15 to 370°K was examined. Irradiated crystals of ZnF_2 and MgF_2 were bleached with ultraviolet light to create F_2 centers. The bands resulting from this treatment were determined by analysis of spectra taken at temperatures from 4 to 350°K. Results are given: three principal absorption bands, peaking at 3.5, 5.2, and 6.1 eV, were produced in ZnF_2 by irradiation at temperatures below 235°K. At 235°K and above, only the two highest-energy bands were found. Both these latter bands exhibited similar growth characteristics. The 5.2-eV band was tentatively identified as that arising from the F center. From the energy required to produce one F center, it was determined that a photolytic damage process is most likely operative in this material rather than one requiring displacement of lattice atoms by elastic collision processes. At 15, 80, and perhaps 145°K, the F band grew in a nonsaturating manner. Growth was more rapid with increasing temperature in this regime. Above 145°K, the growth saturated at relatively low doses, and the saturation level decreased with increasing temperature. It was shown that the observed damage rates of ZnF_2 at various temperatures could be qualitatively understood using a modification of a model which successfully explains similar data for MgF_2. Absorption bands with peaks near 3.5 and 4.1 eV in bleached, irradiated ZnF_2 were tentatively identified as arising from the C_1F_2 center and the σ transition of the $C_{2h}F_2$ center respectively. The π transition of the $C_{2h}F_2$ center was found at 4.7 eV. The lattice mode dominant in broadening the σ transition at 4.1 eV was found to have a frequency of 5.7×10^{12} Hz. The π transition of the $C_{2h}F_2$ center in both ZnF_2 and MgF_2 was found to peak near 4.7 eV. The data also suggest that the π transition of the $D_{2h}F_2$ center in MgF_2 peaks near 5.1 eV. (Diss. Abstr. Int., B)

16123 D.T.A. STUDY ON OXIDATION OF CARBON AND GRAPHITE. Honda, T.; Saito, T.; Horiguchi, Y. (Japan Atomic Energy Research Inst., Tokai). Tanso; No. 72, 14-20(Feb 1973). (In Japanese).

The change of the D.T.A. curve for carbon and graphite under air oxidation was studied by the micro differential thermal analysis (D.T.A.) method. It was found that the temperature of the peak maximum (T_m) represents some intrinsic carbon properties: the T_m value seemed to correspond to its reactivity for oxidation, and a certain relation was observed with crystalline size $L_c(002)$ and lattice spacing C_0. The D.T.A. curve for reactor-grade graphite showed a single exothermic peak. In case of binary mixture of two types of carbon, some shifts of the peak positions in the D.T.A. curve were observed. The peak shape and peak position for carbonized furfural resin were found to vary remarkably with heat-treatment temperature (H.T.T.). For the 2460°C H.T.T. sample, two sharp peaks were observed in the x-ray diffraction profile and also in the D.T.A. curve under air oxidation. It was suggested that the 2460°C H.T.T. may be constituted of at least two kinds of carbons with different oxidation reactivities. (auth)

16124 DYNAMIC MECHANICAL PROPERTIES OF POLYOXYMETHYLENE. V. Miki, K.; Nakamura, S.; Kaneko, M. (Hokkaido Univ., Sapporo). Rep. Progr. Polym. Phys. Jap.; 13: 259-262(1970).

Single crystals were prepared from 0.1 wt % cyclohexanol solution of polyoxymethylene, Du Pont Delrin 150X, by ambient cooling. The crystals were then dried for a week at room temperature in a vacuum desiccator. Then a small compressive load was applied to the crystals placed between two sheets of Teflon disk with a laminating press at room temperature. The single crystals were finally compacted to a mat ~0.1 cm thick and 5 cm in diameter. Density was 1.465 g/cc at 25°C. Specimens were cut out from the mat with a heated razor. Dynamic measurement was made at constant frequency of 0.5 Hz with a torsion-pendulum apparatus. Effect of irradiation with gamma rays was examined on one of the annealed mats. Upon annealing the samples at progressively higher temperatures above 160°C, the α peak of relaxation curves decreased in magnitude, and the γ_1 and γ_2 peaks moved to higher temperature. The β_2 peak decreased in magnitude and moved to higher temperature after annealing at 165°C. After annealing at 169°C, the β_2 peak increased in magnitude and exceeded that of the γ_1 peak. After annealing at 190°C, the α, β, and γ peaks occurred at the same temperatures as in melted and recrystallized polyoxymethylene. (JA)

16125 ELECTRICAL PROPERTIES OF PHOSPHORUS-DOPED SILICON LAYERS OBTAINED BY ION IMPLANTATION THROUGH A PASSIVATING OXIDE. Verjans, J.; Van Overstraeten, R.; Pattyn, H.; De Keersmaecker, R. (Univ., Louvain, Belgium). Solid-State Electron.; 16: No. 7, 779-785(Jul 1973).

The electrical properties of phosphorus-doped silicon layers obtained by ion implantation through a passivating oxide are studied. The quality of the fabricated n^+p diodes is investigated. The influence of the process parameters and of the crystal orientation on the sheet resistance of the n^+ layers is studied. It is shown that sheet resistances higher than 1 k$\Omega/\square$ with a good linearity and a very low temperature coefficient can easily be obtained in a reproducible way. (UK)

16126 PREPARATION OF ARTIFICIAL GRAPHITES OR GRAPHITE-LIKE MATERIALS BY MEANS OF CONTINUOUS MIXING OF BINDERS AND FILLER GRAIN. Luhleich, H.; Nickel, H. (to Kernforschungsanlage Juelich GmbH). German Patent 2,132,492. 25 Jun 1973. 9p. (In German).

A process is described for the preparation of artificial graphite or graphite-like materials, in particular of fine-grained graphite from a suspension of filler material in organic solution of a binding medium. The suspension is injected into the carrier fluid in a mixing chamber, by means of a mixing nozzle so as to uniformly coat the filler grains with the binding material. The mixture of the filler, binding medium, carrier fluid, and solution medium is heated and transferred to a mold in which the filler grains coated with the binding medium strongly reject the liquid, thus facilitating the separation. (GE)

16127 GAMMA IRRADIATION (^{60}Co) INFLUENCE ON THE ELECTRICAL PROPERTIES OF SOME FLUORINE DERIVATIVE COMPOUNDS IN THIN FILMS. Golavcenco, I.; Rusu, G. I.; Rusu, M.; Stefan, V.; Ciornea, D. (Univ., Iasi). An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.; 17: No. 1, 61-66(1971).

Thin films were prepared by growth from solution, on glass substrates. A linear increase of electric resistivity with increasing irradiation dose was observed. After irradiation, the electric resistivity dependence on thickness does not change. The activation energy from the slope in the intrinsic conduction region has the same value for both the irradiated and nonirradiated films. The radioinduced point defects do not disappear after heat treatment between 300 and 420°K. (auth)

16128 GAMMA-RAY-IRRADIATION METHOD APPLIED TO THREE-DIMENSIONAL THERMAL PHOTOELASTICITY. Gross-Petersen, J. F. Exp. Mech.; 12: No. 9, 414-419(Sep 1972).

The irradiation sensitivity of a number of epoxy materials was determined in order to find more sensitive materials suitable for the fixation of photoelastic fringe patterns by gamma-ray method. Short-chain resins cured with amine hardener were found to be suitable for this purpose; moreover, the addition of "trimethacrylate" to the resin reduced the required irradiation dose by about a mrad. The fixation of birefringence by gamma-ray irradiation was applied to determine the thermal stresses in a thick-walled cylinder with a temperature gradient along the radius. Experimental results and those calculated analytically were found to be in good agreement. Case investigated was considered as a two-dimensional problem and for this reason the birefringence was determined by means of the slicing technique. In a three-dimensional problem it is not possible to find stresses by a similar method because, in general, stresses are released. In this case a nondestructive method is necessary to accomplish the gamma-ray method. (App. Mech. Rev.)

16129 AN ESR STUDY OF F_2^{3-} IN γ-IRRADIATED $KASF_6$. Subramanian, S.; Rogers, Max T. (Department of Chemistry, Michigan State University, East Lansing, Michigan 48823). J. Chem. Phys. 58: No. 7, 3082-3088 (1 Apr 1973).

An ESR study of single crystals of $KAsF_6$, γ irradiated and observed at 77 °K, has been made. A three-fluorine center similar to the V_1 center, F_2^-, has been identified, and the principal components and directions for the g tensor, and for the fluorine hyperfine interaction tensors, have been obtained. The center is nonlinear with bond angle $F\text{-}F\text{-}F = 150° \pm 3°$, the odd-electron density being larger on the central fluorine atom and smaller on the two equivalent end fluorine atoms of the radical. INDO calculations suggest that it is a σ-type radical with the unpaired spin density distributed in the fluorine orbitals lying in the plane of the three atoms. (auth)

16130 THERMAL ANNEALING OF RADIATION DAMAGE IN NaCl CRYSTALS STUDIED BY POSITRON ANNIHILATION TECHNIQUES. Blair Nicholas, J.; Tumosa, Charles S.; Ache, Hans J. (Department of Chemistry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061). J. Chem. Phys. 58: No. 7, 2902-2905 (1 Apr 1973).

The thermal annealing of radiation damage induced by gamma radiation in NaCl crystals is studied by positron annihilation techniques. The results show that the concentration of positron annihilation centers (A center) decreases quickly at first upon heating, but then more slowly until a very slowly decreasing region, a "pseudoplateau" is reached. The A-center concentrations at which these pseudoplateaus are obtained depend on the temperatures at which the annealing processes are carried out. The kinetics of the annealing as observed by the positron annihilation technique is consistent with a bimolecular reaction model. The experimentally obtained activation energy for this process is $\simeq$1.2 eV; this suggests the elimination of positive ion vacancies aggregates, which act as positron annihilation centers, by migrating anion vacancies at elevated temperatures. (auth)

16131 1972 ANNUAL BOOK OF ASTM STANDARDS. Part 27. Plastics: General Methods of Testing, Nomenclature. Philadelphia; American Society for Testing and Materials (1972). 957p. $27.00.

This volume is one of 33 and contains all current formally approved ASTM standard and tentative test methods, definitions, recommended practices, classifications, specifications, and other related material. (JRD)

16132 MEASUREMENT OF STORED ENERGY OF KBr AFTER 4.6°K REACTOR IRRADIATION. Cruz-Vidal, B. A.; Wehr, G.; Boening, K.; Vogl, G. (Technische Univ., Munich). J. Phys. Chem. Solids; 34: No. 8, 1335-1342(Aug 1973).

Four KBr single crystals were irradiated at 4.6°K in the core of the Munich Nuclear Reactor for periods of 100 sec, 10 min or 1 hr, respectively. After irradiation the stored energy of the samples was measured in a differential-heat-flow calorimeter at heating rates of 0.29°K/min and 1.1°K/min. At 0.29°K/min peaks of stored energy release were resolved near 11 and 20°K and at 25, 38, and 45°K. An attempt was made to evaluate the corresponding activation energies using two different methods. The 25°K annealing stage is due to a first order recombination reaction. The annealing stages near 20, at 38 and at 45°K do not correspond to first order reactions. The results are compared with annealing studies on low temperature x-irradiated KBr crystals. (auth)

16133 GRAPHITIZABILITY OF CARBON. Volkov, G. M.; Leont'ev, E. A.; Lopatto, Yu. S.; Khakimova, D. K.; Khromenkov, L. G. Inorg. Mater. (USSR) (Engl. Transl.); 9: No. 1, 125-127 (Jan 1973).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 9: No. 1, 140-142(Jan 1973).

Carbon glass–ceramics, without (US) and with 10% boron (USB), and "reaktoplast" coke (RC) (vitreous carbon) were investigated. Graphitization was promoted for 1 h at 2000 to 2800°C by either the B addition or Pt. Broadening of the x-ray reflections (110) and (001) was used as a measure of structural perfection. The hypermolecular structure of USB is completely reconstructed after treatment at 2200°C. Successive stages in graphitization of RC were followed; outside the contact with Pt, RC is not graphitized even at 2800°C. (DLC)

16134 MECHANICS OF FAILURE OF FIBROUS COMPOSITES. Rosen, B. W.; Dow, N. F. (General Electric Space Science Lab., King of Prussia, PA). pp 611-674 of Fracture: An Advanced Treatise. Vol. VII. Liebowitz, H. (ed.). New York; Academic Press, Inc. (1972).

A review of analyses of the failure mechanics of fibrous composites is presented. The mechanical and geometrical characteristics of fibers, which lead to the unique-failure modes of these composites, are described. The influence of the matrix properties on the failure levels is emphasized. A description is presented of analyses of the strength of a uniaxial fibrous composite in simple tension and compression in the fiber direction, and in shear, both in the fiber plane and in the transverse plane. The use of these strength theories in the definition of a laminate-failure criterion is then described. Experimental methods for the measurement of composite material strength are discussed and new methods are proposed. Results demonstrate that while composites exhibit many new modes of failure, they include materials with a far greater strength and stiffness potential than commonly available homogeneous materials. The use of studies of the internal mechanics of fibrous composites to define guidelines for the development of improved materials is emphasized. (36 figures, 39 references) (auth)

16135 INFRARED STUDIES OF RADIATION DAMAGE IN N-TYPE SILICON. Cohen, G. Lafayette, IN; Purdue Univ. (1972). 71p. University Microfilms Order No. 73-15,789.

Thesis (Ph. D.)

Low-temperature radiation annealing in N-type silicon is explored, using infrared-absorption measurements. N-type pulled (Czochralski) silicon was irradiated with 1.5-MeV electrons to a flux of 2.0×10^{17} el/cm^2, with $T_B = 85°K$, revealing irradiation-induced absorption bands at 11.96μ (vacancy-oxygen, or A-center), and at 10.84μ (921 cm^{11}) and 10.72μ (931 cm^{-1}). These latter bands were tentatively identified as due to an interstitial carbon atom. Irradiations at 1.0 MeV, $T_B < 35°K$, to a flux of 3.0×10^{17} el/cm^2, and at 1.4 MeV, $T_B < 35°K$, to a flux of 2×10^{17} el/cm^2, produced no observable changes in any of these bands. Further attempts at radiation annealing of these bands were also unsuccessful. Irradiation of floating-zone Prefex silicon with 1.5-MeV electrons, to a total flux of 10^{18} el/cm^2, with T_B increasing from 82 to 250°K revealed no irradiation-induced defects over the range 1.8 to 12.65μ. 4.5-MeV irradiations on a floating-zone sample, $T_B = 280°K$, flux = 10^{18} el/cm^2, revealed strong absorption bands at 3.61 and 3.45μ, associated with the divacancy. Further 1.5-MeV irradiations, $T_B = 15°K$, revealed indications of radiation annealing of these bands. As much as 32% of the 3.61-μ band is radiation annealed. Further study shows the annealing occurs when a high-temperature irradiation is followed by a low-temperature irradiation, even though the energy remains the same. Lowering the energy of the radiation-annealing beam appears to increase the efficiency of the annealing process. A model for lack of radiation annealing in the pulled sample and the occurrence of radiation annealing of the 3.61- and 3.45-μ bands in the floating-zone sample is discussed. A modification of the MacKay model, employing the mobile silicon interstitial, is introduced, which incorporates the mounting evidence of the carbon impurity serving as a deep interstitial trap. The oxygen is suggested as playing the role of "shielding" the silicon interstitial from these deep carbon traps. This may be done by combining with the carbon to form a carbon–oxygen center, or by capturing the interstitial itself to form an oxygen-interstitial center. (Diss. Abstr. Int., B)

16136 ELECTRON ENERGY LOSS STUDIES OF POLYMERS DURING RADIATION DAMAGE. Ditchfield, R. W.; Grubb, D. I.; Whelan, M. J. (Oxford Univ.). Phil. Mag.; 27: No. 6, 1267-1280(Jun 1973).

Some organic crystalline polymers (polyethylene, polystyrene, polyoxymethylene) have been studied using the energy-analyzing electron microscope (Cundy, S. L., et al., J. Scient. Instrum., 43: 712 (1966)) to determine the energy loss spectra of fast electrons passing through an extremely small specimen. The polymers rapidly become disordered during observation in the electron microscope, because of chemical and physical changes induced by the imaging beam of fast electrons. These changes also effect the loss spectra. The spectrum from each polymer investigated was quite similar to that of amorphous carbon, and the energy

loss of the main peak always increased with irradiation. This has been interpreted as an increase in specimen density on the basis of a simple theory. (auth)

16137 DYNAMIC OBSERVATION OF THE FORMATION OF DEFECTS IN SILICON UNDER ELECTRON AND PROTON IRRADIATION. Matthews, M. D.; Ashby, S. J. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 27: No. 6, 1313-1322(Jun 1973).

Silicon single-crystal samples were irradiated in a high-voltage (1 MeV) transmission electron microscope. The defects formed are described as a function of specimen temperature and compared with similar defects formed by proton irradiation in an accelerator–electron microscope link. The defects are contrasted with those obtained with heavy ions with particular regard to possible mechanisms for the crystalline to amorphous transition which was not seen for electron and proton bombardments. For irradiations at 450°C needle-shaped precipitates were formed on (113) planes. (auth)

16138 FATIGUE MECHANISM OF X-IRRADIATED AMORPHOUS Se LAYERS. Rakuskas, Yu. K.; Kalade, Yu. A.; Montrimas, E. A. (Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys; 12: No. 4, 611-621(1972). (In Russian).

The physical model of x irradiated Se electroradiographic layers takes into account photogeneration, capture, and recombination of carriers and explains their fatigue. Analytical expressions of fatigue (i.e., formulas to determine the photosensitivity of fatigued and unfatigued layers) have been derived. The dependence of fatigue on irradiation dose, layer thickness, and on capture and recombination level density and their cross sections were theoretically determined. The theoretical regularities obtained were confirmed by experimental data. It was determined that for Se electroradiographic layers the carrier capture and recombination probabilities must be different when an electric field is applied and when there is no electric field. The density of capture levels responsible for the fatigue process as well as carrier recombination and capture coefficients were estimated in these layers. (auth)

16139 Se ELECTRORADIOGRAPHIC LAYERS DISCHARGE MECHANISM IN CASE OF X-RAY IRRADIATION. Kalade, Yu. A.; Montrimas, E. A.; Rakauskas, Yu. K. (Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys; 12: No. 4, 597-610(1972). (In Russian).

A physical model of the discharge mechanism, taking into account carrier photogeneration as well as capture and recombination, is proposed for Se electroradiographic layers produced by x irradiation. Analytical expressions of photosensitivity have been derived. The dependence of layer photosensitivity on thickness was determined for various x-ray hardnesses. In the x-ray region the spectral distribution curves of photosensitivity were also calculated. Theoretical regularities were confirmed by experimental data, and it was found that the calculated and measured relations are in good agreement. (auth)

16140 RADIATION RESISTANCE OF RESOL COMPOUNDS WITH ELECTRON CONDUCTING FILLERS. Ambardanishvili, T. S.; Dundua, V. Yu.; Kiknadze, G. I.; Kolomiitsev, M. A. Soobshch. Akad. Nauk Gruz. SSR; 69: No. 3, 569-572(Mar 1973). (In Russian).

Changes of the mechanical properties of resol-base compounds with graphite and aluminum filler caused by neutron and γ irradiation have been studied. It is shown that the mechanical strength of a graphite compound increases due to the joining of resin to the filler, whereas in the case of aluminum its strength does not change. (auth)

16141 THEORY OF CRYSTAL DISTORTION AND ZEEMAN EFFECTS IN RARE-EARTH COMPOUNDS WITH ZIRCON STRUCTURE. Kambara, T.; Haas, W. J.; Spedding, F. H.; Good, R. H. Jr. (Ames Laboratory-USAEC and Departments of Chemistry and Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. B 7: No. 8, 3945-3953 (15 Apr 1973).

In some rare-earth crystals there is a second-order phase transition from orthorhombic structure at lower temperatures to tetragonal at higher. A partial theoretical analysis of these materials is given in this paper. The basic idea is to consider the rare-earth ion in a crystal field interacting with a strain mode of the crystal. The temperature dependence of the interactions is assumed. The subjects discussed are the ground-state levels and their g values, the effect of a magnetic field on the transition and on the direction of crystal distortion, and the Zeeman effect for the optical-absorption spectrum. (auth)

16142 THE EFFECT OF NEUTRON IRRADIATION ON THE PHOTOCHROMIC EFFECT IN CERIUM-ACTIVATED GLASSES. Kuznetsov, A. A.; Kruglova, A. V. Sov. J. Opt. Technol. 39: No. 8, 507-508 (Aug 1972).

16143 AXIAL- TO PLANAR-CHANNELING TRANSITION. Mea, G. Della; Drigo, A. V.; Russo, S. Lo; Mazzoldi, P. (Istituto di Fisica dell'Università, Unità del Gruppo Nazionale di Struttura della Materia del Consiglio Nazionale delle Ricerche, Padova, Italy); Bentini, G. G.; (and others). Phys. Rev. B 7: No. 9, 4029-4041 (1 May 1973).

Axial and planar channeling of 1.0- to 2.8-MeV protons in silicon was studied both by transmission in some μm-thick crystals and by Rutherford backscattering. Transmission experiments were simulated by a Monte Carlo program. A sharp transition between axial and planar channeling is observed by measuring both the effective stopping number, B, of channeled particles and the dechanneled fraction. Computer simulations exhibit the same features and show that, at the transition, the transverse energy component is such as to produce a maximum probability of hitting the atoms. These experiments also give some criteria for the interpretation of backscattering measurements. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstract 16167.

16144 (BARC-I-165, pp 1-5) MATERIAL ACCOUNTING IN THE NUCLEAR FUEL CYCLE. Srinivasan, N. (Bhabha Atomic Research Centre, Bombay). 1972.

From seminar on accountability and management of fissile materials; Trombay, India (13 Apr 1971).

The approach to nuclear material accounting in the various stages of the nuclear fuel cycles is described. As the freshly generated nuclear material is first encountered at the input point of a reprocessing plant, this point has assumed great significance in nuclear material accounting. Accounting becomes most complicated at this point. Continuous development work is in progress in many countries to simplify the procedure and at the same time to improve the reliability of the various methods. In-line techniques are being studied but at present do not promise the required accuracy except for waste streams where accuracy required is not large. Periodically, detailed accounting by washing out the entire plant is required to reconcile differences in book inventories and to establish material unaccounted for, the magnitude of which indicates the effectiveness of the accounting procedures. In assessing the significance of MUF values, statistical criteria are applied. Political and international concern over the control of fissile materials has injected a different dimension to fissile material accounting and has resulted in a concerted effort all over the world towards evolving dependable methods of accounting for nuclear material. (INIS)

16145 (DP-1327) CUDS: COMPUTER PROGRAM FOR PROCESSING CUMULATIVE DATA STATISTICS. Anderson, L. G.; Lewis, C. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab). Jul 1973. Contract AT(07-2)-1. 42p. Dep. NTIS $4.00.

The Cumulative Data Statistics (CUDS) program was written in FORTRAN IV for an IBM System/360-195 to statistically analyze volume calibrations for the accountability tanks at the Savannah River Plant. The management of nuclear materials requires accurate measurement data and a knowledge of the uncertainty associated with the measurements (weighing, sampling, analyzing, and converting instrument readings to volume). The program offers optimum flexibility in processing and listing discrete data, thus providing a valuable tool for calculating liquid tank inventories. (auth)

16146 SAFEGUARDS IN NUCLEAR TECHNOLOGY. Gupta, D.; Seetzen, J. Aussenpolitik; 21: 338-347(1970). (In German).

Proceeding from the principle that industrial and commercial interests of enterprises must remain untouched, the authors conclude that safeguards provisions have to be restricted to keeping and auditing accounts of the fissile material. The purpose of nuclear safeguards measures is to prevent any diversion of fissile material, and not to control nuclear industry. Therefore, commercial interests and the right to compete should not be restrained. Thus a major item of future international negotiations in this field should be to agree upon appropriate procedures to prevent any misuse of safeguards measures. (GE)

16147 NONDESTRUCTIVE ASSAY TECHNIQUES AND APPLICATIONS FOR SAFEGUARDS AND MATERIAL ACCOUNTABILITY. Johnson, W. S. (Eberline Instrument Corp., Santa Fe, NM). Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). vp.

From specialist meeting on nuclear technology; Frankfurt am Main, Germany (22 Feb 1972).

A survey is given on the mode of operation of the safeguards instruments developed at LASL which are commercially available, i.e., passive gamma assay—determination of ^{235}U and ^{239}Pu by measurement of the gamma energies of 185.6 keV and 413.7 keV, respectively using NaI and Ge(Li) detectors; passive neutron assay—coincidence counting of neutrons produced by spontaneous fission in Pu isotopes and/or natural uranium; and active neutron assay—irradiation of the sample with neutrons (^{252}Cf neutron source) and measurement of resulting fission neutrons and gamma rays. (GE)

Disposal and Storage

Refer also to abstracts 15404, 15411, 15475, 15476, and 15940.

16148 (ORNL-tr-2684-B) DISPOSAL OF RADIOACTIVE WASTES FROM NUCLEAR POWER PLANTS. Part 2. Appendices. Final Report for the Period January 1, 1970—December 31, 1971. Witte, H.; Herzog, J.; Christ, R. Translated from a German report. 45p. Dep. NTIS $4.25.

The treatment and disposal of radioactive wastes from light-water reactors are discussed. Properties of bitumen for waste fixation are given. Guideline prices for transportation and processing of radioactive preconcentrates from reactors are given. (TFD)

16149 RADIOACTIVE WASTE DISPOSAL WITH SPECIAL REFERENCE TO THE ITALIAN SITUATION. Com. Naz. Energ. Nucl., Notiz.; 19: No. 4, 73-106(Apr 1973). (In Italian).

A report was prepared by a study group organized by CNEN's Radiation Dept., discussing the various problems relating to the final disposal of low-, medium- and high-level radioactive wastes, particularly in view of the increase in the number of nuclear power plants. The report makes special reference to Italy's present and future situation. (auth)

Handling Equipment and Procedures

Refer also to abstracts 15414 and 15463.

16150 (MRR-96) CRITICALITY CALCULATIONS OF THE POISON EFFECT OF BORON RASCHIG RINGS IN PLUTONIUM NITRATE SOLUTIONS. Thomas, W.; Rueckert, N. T. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Dec 1971. 17p. INIS.

Criticality calculations for plutonium nitrate solutions poisoned by boron containing Raschig rings have been performed with the goal of checking and comparing various computational techniques against recent experiments. The verification of these experimental values is satisfactory for heterogeneous cell calculations in the case of borosilicate glass Raschig rings, but rather poor for stainless steel rings. In this field further experiments are needed to provide clear data for criticality safety analysis. Derivations of generalized criticality data are made from the experimental and computed values to establish guidelines for related safety problems. Further, the influence of energy group distribution on resulting multiplication factors has been considered. KENO Monte Carlo calculations were carried out to determine the radioactivity effect of parallel poison tubes in comparison with random arrays of Raschig rings. K_∞ was found to be about 1% less for mutually perpendicular oriented rings than for parallel pipes. (auth)

16151 PERSONNEL DECONTAMINATION FACILITY (2 APR 1973) (ENGINEERING MATERIALS). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). (CAPE-2356). 19 drawings.

Facilities for emergency surgery on contaminated accident victims are described. The receiving and cleanup rooms were modified to provide a shielded operating room for protection of medical personnel. It includes a shielded cell with a specially designed operating table arrangement with two surgeon shields and one anesthetist shield mounted on trolleys, and two portable shields mounted on casters. The table arrangement allows the contaminated patient to be packed in ice or submerged in water as necessary to assist in decontamination or to increase the protection of medical personnel. Installation of a concrete shield wall protects personnel in the remainder of the building. A seamless, conductive floor covering eliminates static electricity and facilitates decontamination. Alterations to the existing heating and ventilating system ensure containment and exhaust of airborne radioactive contamination through a high-efficiency particulate air filter to the atmosphere. A portable electromagnet provides for removal of iron or steel particles from patients. A sonar wave foreign body finder and a shielded receptacle and cover for containment of particles removed from patients are also provided. The present operating facilities are retained for special emergency treatment of patients after cleanup or for cases where radiation exposure to medical personnel is minimal. Shielding is provided for medical personnel within the facility and the facility itself is properly shielded from the remainder of the building. (auth)

16152 STORAGE AND HANDLING FACILITY FOR CALIFORNIUM-252 MEDICAL SOURCES. Veerling, J. P. Jr.;

Oliver, G. D. Jr.; Moore, E. B. (Univ. of Texas, Houston). Health Phys.; 25: No. 2, 163-167(Aug 1973).

A shielded facility for storage and handling of up to 300 μg of ^{252}Cf afterloading cells and tubes was designed and constructed. The main shield consists of a centrally located lead pot surrounded by borated water-extended-polyester. A built-in, curved personnel barrier with sliding Lucite eye shield enables safe and rapid handling of sources during calibration, inventory, cleaning operations and movement to and from the source storage rods. The design radiation levels for the mixed neutron-gamma field from ^{252}Cf were 3 mrem/hr at the surface of the shield, less than 2 mrem/hr in the corridor and adjacent radiotherapy patient room, and less than 0.2 mrem/hr in the nursing office below and patient room above. The protection survey of the completed facility and its environs confirmed the calculations and adequacy of the constructed shield. (auth)

16153 CRITICALITY SAFETY CONTROL FOR NUCLEAR FUEL FACILITIES IN JAPAN. (Atomic Energy Society of Japan, Tokyo). Nippon Genshiryoku Gakkaishi; 15: No. 2, 102-114(Feb 1973). (In Japanese).

A survey of the state of development and future prospects of the different processes constituting the nuclear fuel cycle in Japan, and on problems encountered in criticality safety is reported. The present status and problems concerning criticality safety design and control of (a) low and highly enriched uranium fuel fabrication facilities, (b) plutonium fuel fabrication facility, and (c) the reprocessing plant are discussed. The working groups made a calculation on the criticality safety of the UO_2 powder storage facility, the ADU precipitation process, and of the dissolver of the reprocessing plant. In keeping with the industrial scale of the different processes constituting the nuclear fuel cycle in Japan, the organization of basic research in criticality safety, training of specialists, establishment of criteria or guides governing criticality safety, and initiation of a data center and/or an experimental facility are required. (auth)

Transportation

16154 (CONF-730546-1) RADIOACTIVE MATERIAL SHIPPING PACKAGES: THEIR DESIGN AND SAFETY ANALYSIS. Shappert, L. B. (Oak Ridge National Lab., Tenn.). [nd]. 12p. Dep. NTIS $3.00.

From Southern Interstate Nuclear Board Meeting; Oak Ridge, Tennessee, USA (16 May 1973).

The types of radioactive sources and shipping containers in present-day use and the steps the designer must go through to assure himself that the package meets the regulations are discussed. It was concluded that: shipments of radioactive materials will continue to increase in numbers in the future; if quantities of radioactive materials are to be shipped, whose release to the environment could cause a public health hazard, the packages must be evaluated under both normal and severe accident test conditions; the AEC is spending large sums of money to assure the continued development of packages capable of shipping all kinds of radioactive material in a manner that ensures that public safety is considered first and foremost; recent changes require quality assurance programs to be written for the cask design and fabrication. These plans will be approved by the AEC; and the safety record in the shipment of radioactive materials in the past has been excellent. (RCK)

16155 (ORNL-TM-4262) LMFBR SPENT FUEL TRANSPORT: DOWTHERM A HEAT TRANSPORT TEST. Irvine, A. R.; Klima, B. B. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 17p. AT.

Dowtherm A was found to be an effective heat transport fluid both inside and outside the wrapper of a mockup of an LMFBR fuel assembly. The mockup used 0.250-in.-diam fuel rods that were spaced 0.060 in. apart by spiral-wound wires. The test was conducted with the assembly mockup in a horizontal position. (auth)

16156 (STI/PUB-312) MARITIME CARRIAGE OF NUCLEAR MATERIALS. Proceedings Series. Proceedings of a Symposium, Stockholm, June 18–22, 1972. (International Atomic Energy Agency, Vienna (Austria)). Feb 1973. 400p. (In several languages). (CONF-720682-). IAEA $15.00.

A separate abstract was prepared for each of the 31 papers presented at the conference. In addition, a separate abstract was prepared for each of the two panel discussions and annex 1 contained in the proceedings. (RCK)

For abstracts of individual papers see: 16159–16192.

16157 INTEGRATED TRANSPORT SYSTEM FOR NUCLEAR FUEL ASSEMBLIES. Trudeau, A. G.; Haagensen, D. F. U. S. Patent 3,732,427. 8 May 1973. Filed date 17 Mar 1971. 14p.

A transport system for conveying nuclear fuel assemblies from a nuclear power plant to a plant for reprocessing or to a burial ground comprising a unique two part shipping cask and a trailer transporter for the cask or casks, constructed on the single spar concept is described. The novel cask as well as the transporter are constructed with fast neutron as well as gamma ray attenuation materials thereby providing adequate shielding for the formidable array of radiation emitted by spent fuel assemblies used in recent advanced light water converter reactors as well as first generation fast breeder reactors. The trailer transporter may be interchangeably wheeled for transit over conventional roadways or railways, or a modified rail car may be provided onto which the entire cask and trailer transporter may be loaded. A plurality of such cars so loaded form a unit train, having a locomotive to haul the train and a control car immediately therebehind to monitor heat, radiation and stress parameters of each loaded car making up the unit train. (Official Gazette)

16158 LMF CASK FOR N-REACTOR FUEL (ENGINEERING MATERIALS). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). (CAPE-2342). 10 drawings.

A modified cask that is used for shipment of uranium in the form of ruptured N-Reactor (NPR) fuel from Nuclear Fuel Services at West Valley, New York, to another reprocessing site, is described. Each cask contains one carrier basket containing eight cans of fuel. The cask is equipped with an absolute (HEPA) filter for venting any gas release. The fuel cans, carrier and cask are filled with an argon atmosphere to avoid possibility of oxidation of radioactive material. N-Reactor fuel can be shipped safely in LMF casks with two restrictions: ^{235}U enrichment and total mass ^{235}U. One thousand kg of uranium with initial enrichment ≤0.95% ^{235}U (9.5 kg ^{235}U) is safe in any arrangement regardless of uranium form and H/U ratio (moderator) provided neutron moderating materials Be, D, and C are limited to trace amounts. Three LMF casks, each containing up to 273 pounds (124 kg) uranium as N-Reactor fuel, are safe as a Fissile Class III shipment. The package withstands conditions likely to occur in normal transport and hypothetical accident. (RCK)

16159 IMPORTANCE OF MARITIME CARRIAGE OF NUCLEAR MATERIALS FROM THE ECONOMIC VIEWPOINT: PRESENT SITUATION AND DEVELOPMENT. Warrikoff, A. (Reaktor Brennelemente GmbH, Wolfgang, Ger.). pp 3-11 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The values of the various segments of the nuclear fuel cycle do not correspond with the value of the respective maritime carriage. This is due to the very different safety and packaging requirements for the specific hazards. Therefore the shares of freight, insurance and containers of the total cost of maritime carriage differ significantly for the various types of nuclear material. A forecast for the monetary volume of maritime carriage for Western Europe is made from 1975 to 1985. (auth)

16160 APPLICATION OF RADIOLOGICAL PROTECTION PRINCIPLES TO THE TRANSPORT OF RADIOACTIVE MATERIALS. Freke, A. M. (National Radiological Protection Board, Harwell, Eng.). pp 15-26 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The nature and origins of radioactivity and the possible radiation hazards which may accompany the use of radioactive material by man, in relation to external and internal radiation exposure are discussed. The basic concepts in the field of radiological protection are introduced leading to the derivation of permissible levels, limiting exposure to radiation, and the embodiment of numerical limits in the recommendations of the International Commission on Radiological Protection. The detection and measurement of radiation and methods of control with particular reference to the transport industry are discussed. (auth)

16161 SPECIAL PROBLEMS INVOLVED IN THE MARITIME CARRIAGE OF FISSILE MATERIALS. Williamson, S. (British Nuclear Fuels Ltd., Risley, Eng.). pp 27-33 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

An outline of the types of packaging and test requirements is given. Fissile material likely to be transported is discussed together with fissile characteristics and the classification of fissile packages. Reference is made to the use of transport indexes and how they are derived, and conclusions are given. Because of the care and attention given to the design of packaging, the problems encountered in the maritime carriage of fissile materials should seldom be more than those commonly associated with the shipment of heavy and bulky loads. (auth)

16162 DESCRIPTION OF HAZARDS SPECIFIC TO MARITIME CARRIAGE. Rolfs, K. (International Chamber of Shipping, London). pp 37-42 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The maritime transport of radioactive materials from the practical point of view considering that types of ships, other dangerous goods aboard the same ship, influences of the sea and environmental aspects could affect the carriage of these materials is discussed. (auth)

16163 ANALYSIS OF THE MAIN TECHNICAL PROBLEMS RELATING TO THE MARITIME CARRIAGE OF RADIOACTIVE MATERIALS. Sousslier, Y. (CEA, Chatillon-sous-Bagneux, France). pp 43-50 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The measures that have to be taken in connection with the transport of radioactive materials differ widely, depending on the nature of these materials, which vary to a very great extent. This explains the apparent complexity of the regulations on the subject, the provisions of which have been drafted in a manner to ensure that, regardless of the conditions of transport, there can be no radiological consequences either for the public or for the carrier. This has led to the development of special equipment (protective covers, dampers, insulating material), which enables the packaging for large amounts of radioactive material (Type B) to pass a series of very stringent tests (including falls from a height of 9 m and exposure to fire for half an hour). These tests also cover maritime accidents in which the decelerations are comparable with those occurring in land accidents and which may involve fires lasting longer but having lower temperatures. The fact that the safety of transport depends on packaging, which is expressed as a function of the material and quantities transported, does not alter the fact that certain types of transport may require special guidelines. Particular attention will have to be paid to the stowage and handling of heavy packages. Clear confirmation of the validity of the rules adopted is provided by the fact that no accident involving radiological consequences has ever occurred, even in the case of land transport, the statistics for which are much more significant in view of the large number of such shipments. (auth)

16164 IAEA REVISED REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Swindell, G. E. (International Atomic Energy Agency, Vienna). pp 57-65 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A brief account is given of the initial preparation and approval in 1961 of the IAEA Regulations for the Safe Transport of Radioactive Materials and of the subsequent revisions in 1964 and 1967. The Regulations form part of the IAEA Safety Standards and are mandatory for the Agency's own work and for assisted projects in Member States. They have also been adopted by almost all international organizations concerned with the transport of dangerous goods and have been taken by many Member States as the basis of their national regulations. The Regulations underwent an additional extensive review starting in 1970. A description is given of the main changes that are proposed in the technical requirements for packaging, in the administrative requirements and in other general requirements for stowage and carriage. The proposed timetable is outlined for future revisions of the Regulations and of the new companion volume of advisory material. (auth)

16165 REGULATIONS LAID DOWN BY THE INTERNATIONAL CONVENTION ON THE SAFETY OF LIFE AT SEA (1960) AND THE IMCO CODE OF PRACTICE FOR MARITIME TRANSPORT OF NUCLEAR MATERIALS. (Inter-Governmental Maritime Consultative Organization, London). pp 67-76 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The IMCO Maritime Dangerous Goods Code is designed to supplement, in a more specific manner, the provisions of the 1960 SOLAS Convention relating to the maritime carriage of dangerous goods. Class 7 of the Code deals specifically with the maritime carriage of radioactive substances. The regulations of Class 7 are based on the IAEA Regulations and are amended and revised from time to time following revisions to the IAEA Regulations. The provisions of the Code are prepared by experts representing Governments and interested shipping and nuclear agencies and bodies, and then recommended by the IMCO Assembly to Governments. The Code as such is not a binding legal instrument but it has been adopted and implemented by the national legislation of over twenty countries. The Code is designed to ensure safety to ship, cargo, persons and the environment. Every effort is made to avoid unnecessary restrictions and consequential expenditure. Hence there are criteria and conditions for excepting certain classes from all or some of the requirements of the Code, in circumstances where such exception will not invalidate the essential rationale of the Code. The Code contains requirements relating to stowage and segregation of radioactive substances for persons, undeveloped film and other dangerous goods, procedures for dealing with nuclear contamination (and decontamination), labelling and marking of packages, provision and kinds of transport documents (including certificates to be provided by the shipper), procedures for dealing with accidents and for avoiding exposure of crew and supplies, and requirements for approval to be given for the shipping, unloading and through-transport of shipments of nuclear material. Class 7 deals with radioactive substances only; however, other classes of the Code deal with other dangerous goods. Where a radioactive substance is exempt from the provisions of Class 7, it may nevertheless be subject to other classes of the Code. (auth)

16166 APPLICATION OF INTERNATIONAL REGULATIONS BY COMPETENT NATIONAL AUTHORITIES. Kolb, W. A. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 81-87 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The national regulations of seven countries, i.e., Canada, Federal Republic of Germany, France, Italy, Norway, United Kingdom, and United States of America are reviewed. With respect to their conformity to international regulations, the following conclusions can be drawn: (1) the technical requirements of nearly all of these countries are in accordance with the IMCO Code or the IAEA Regulations, as far as transport of radioactive materials by sea is concerned; a few differences exist in the USA; (2) with regard to the administrative procedures, no difference between national and international regulations exists in France, Norway, the United Kingdom and, for non-fissile radioactive material, in the Federal Republic of Germany; (3) a special shipment authorization is required in Germany for fissile material in excess of exempt quantities; in France for Fissile Class III shipments; and in Italy for radioactive materials in excess of 2000 Ci and fissile materials in excess of 15 g; and (4) revalidations of foreign approval certificates are required by Canada, Italy, and the USA. (auth)

16167 APPLICATION OF IAEA SAFEGUARDS TO INTERNATIONAL CARRIAGE. Stein, R. M. (International Atomic Energy Agency, Vienna). pp 89-98 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The IAEA Safeguards introduce a new factor in international carriage. The relevant aspects of this subject, dealing with the general framework for agreements in connection with NPT, and the structure and contents of such agreements are discussed. In conclusion, attention is given to the question of the physical protection of nuclear material, and certain recommendations that have been developed on this subject. (auth)

16168 OPERATING EXPERIENCE IN THE MARITIME SHIPMENT OF NUCLEAR MATERIAL. Keese, H. (Transnuklear GmbH, Grossauheim, Ger.). pp 103-114 of Maritime

Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A survey is given of the operating experience gained with maritime shipments to and from the Federal Republic of Germany. The most important shipments of nuclear material are listed and technical problems (containers, handling and stowage, carriage of irradiated material) are discussed. In addition, some of the regulatory and insurance aspects of those shipments are briefly discussed. (auth)

16169 ITALIAN EXPERIENCE IN THE SEA TRANSPORT OF RADIOACTIVE MATERIALS. Gualtieri, G. (ENEL, Rome); Cane, G.; Calori, A.; Failla, L.; Lanzillo, V. pp 115-127 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

Italian experience in maritime transport of radioactive materials refers in particular to operations performed in harbors and more generally to the cooperation given to foreign carriers. The technical, procedural, and administrative aspects which primarily aim at guaranteeing the maximum safety of transport are discussed. After a short review of statistical data concerning number of sea transport and quantities of radioactivity transported during the last six years, the paper refers to experience with harbor handling facilities, to special requirements applicable to sea transports and handling of irradiated fuels, to health physics operating aspects and finally to the Italian legislation and procedures followed by the competent authority in approving packages. In conclusion, it is stated that the great effort spent in safety of sea transport is necessitated by the dangerousness of transported goods, but is aimed at obtaining a safety standard much higher than that normally achieved in transport of conventionally dangerous goods. (auth)

16170 UK EXPERIENCE IN THE MARINE TRANSPORT OF IRRADIATED FUEL. Curtis, H. W. (British Nuclear Fuels Ltd., Risley, Eng.). pp 135-140 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The methods used by British Nuclear Fuels Ltd. for the transport of irradiated fuel from a number of overseas reactors are described. The requirements for the transport of magnox fuel are outlined, as representative of the manner in which a cooling plant can be incorporated in a charter ship. The manner in which this experience has been applied to the later transport of oxide fuels is discussed together with the standards of securement which must be observed. The position of charter ships and standard cargo ships in relation to irradiated fuel transport is discussed together with the versatility which is provided by the use of sea transport. (auth)

16171 REGULATIONS FOR THE MARITIME CARRIAGE OF RADIOACTIVE MATERIALS. Redon, A. (CEA, Chatillon-sous-Bagneux, France). pp 141-146 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The purpose of this paper is to draw attention to a weak link in the transport chain, viz. carriage by sea. The first part examines the regulations which consignors and maritime carriers must conform to, and the extent of their respective liabilities. The second part analyzes the experience of several years of carriage by sea, with emphasis on the loading and unloading stage, which constitutes the weak point, since it is not expressly defined in the regulations and is covered only by guidelines. Particular consideration is given to the case of materials of low specific activity and it is shown that the handling of these materials can lead to incidents of varying degrees of seriousness owing to a lack of attention on the part of shipping firms. It is hoped that experts in the field will work together in the drafting of realistic regulations relating to this aspect of carriage by sea. (auth)

16172 EXPERIENCE OF PORT AUTHORITIES WITH REGARD TO THE TRANSPORT BY SEA OF NUCLEAR FUEL. Horn, A. (Gewerbeaufsichtsamt, Bremerhaven, Ger.). pp 147-153 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The experience of the Bremen and Hamburg port authorities has shown that shippers, harbor authorities and ships crews must become more safety conscious with regard to the transport by sea of nuclear fuel and other dangerous goods in containers. In the past, the following instances have been noted: (1) shipping documents in accordance with harbor regulation and IMCO Code were incomplete; (2) the requirements concerning the PTB-carriage license were not observed; (3) nuclear fuel was unloaded in Bremerhaven before the master of the ship, the port authorities and the transhipment company has been duly informed of this action; (4) containers in which dangerous cargoes were transported were not marked with adequate care; and (5) careless security of the Type 3 packaging in closed containers was observed in many cases. Experience of the transport of nuclear fuel has also shown that the best solution would be if the shipping documents and each Type B packaging were accompanied by a strong envelope containing the details in accordance with IMCO requirements and a brief description of damage, as is usual when other dangerous goods are transported, e.g., acids. In the meantime, both shippers and shipping companies are endeavoring to observe more closely the regulations and licensing requirements for transport by sea and transhipping of nuclear fuel. (auth)

16173 TECHNICAL AND REGULATORY PROBLEMS CONCERNING MARITIME CARRIAGE OF NUCLEAR MATERIALS: PANEL DISCUSSION. pp 159-166 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A panel discussion on the marine transport of nuclear materials is presented. The questions and answers dealt with comparative risk estimates for transport by land and sea; qualifications of stevedores for handling nuclear materials; activity released by Type A packages; shipping regulations in Germany; special facilities for ships involved in transporting radioactive materials; thermal testing of thick-walled containers; and the effects of corrosion and pressure of seawater on containers being jettisoned or lost overboard. (RCK)

16174 EVOLUTION OF THE SYSTEM OF CIVIL LIABILITY IN THE MARITIME CARRIAGE OF NUCLEAR MATERIAL, FROM THE BEGINNINGS UP TO DECEMBER 17, 1971. Lagorce, M. (Commissariat a l'Energie Atomique, Paris). pp 169-177 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

There are three important dates in the evolution of the system of civil liability in the carriage of nuclear materials: 1958, 1968 and 1971. The first date marks the beginning of OEEC's work on the drafting of an international convention on liability in respect of nuclear installations and of the carriage of nuclear materials. Neither the 1960 Paris Convention nor the 1963 Vienna Convention, however, affords a satisfactory solution to the problem of transport, since both of them provide for the application of earlier international agreements on the subject. In 1968, the Paris Convention entered into force but, because of the continuation of the liability of maritime carriers under maritime law and the refusal of their professional mutual insurance companies to cover this liability, operators of nuclear installations face great difficulties in connection with the carriage of nuclear materials by sea. ENEA and IAEA then jointly organized a symposium in Monaco which decided on the need to accord priority to nuclear law over maritime law in the carriage of nuclear materials by sea. After three years of studies conducted jointly by the nuclear and maritime organizations, a diplomatic conference was held under the auspices of IMCO. It approved a new nuclear-maritime convention which was signed on December 17, 1971. This Convention eliminated most of the uncertainties of the previous legal system and seeks to relieve maritime carriers, as fully as possible, of all nuclear liability. The operators of nuclear installations are setting their hopes on the Stockholm symposium as a forum for convincing ship owners and their insurers that they can henceforth accept nuclear materials for carriage without greater reservation than in the case of other hazardous materials. (auth)

16175 BRUSSELS CONVENTION OF DECEMBER 17, 1971 RELATING TO CIVIL LIABILITY IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR MATERIALS: ITS IMPLICATIONS FOR MARITIME LAW. du Pontavice, E. (Univ., Paris). pp 179-198

of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The territorial scope of the 1971 Brussels Convention is discussed including its scope in regard to the concept of accidents; its scope in regard to the provisions of maritime law superseded by Articles 1 and 4 of the 1971 Convention; and the conditions under which the maritime carrier is exempt. The territorial scope is very extensive and this is also true of the concept of nuclear accident. On the other hand, the scope of application, insofar as the superseded provisions of maritime law are concerned, is limited to the conventions and national laws on the maritime carriage of passengers, baggage and goods and to the corresponding national laws, including, in general, the laws on port handling. Thus, the scope of the 1971 Convention in regard to the superseded provisions of the maritime law is still far from negligible, since nuclear materials are often transported with a bill of lading and sometimes even aboard ships carrying passengers. In order for the maritime carrier to be exempt, one of the following conditions must be satisfied: (a) either the operator of a nuclear installation is liable for damage under the Paris or the Vienna Convention, as applicable in the country where the installation is situated; (b) or he is liable under a national law which is equally favorable to the victims. The latter condition will give rise to practical difficulties. The question is whether one must determine in concrete or in abstract terms if the national law is equally favorable and who will carry out the determination. It will be the court which is considering the action against the maritime carrier. However, this court may perhaps not be in a position to decide on the advantages or disadvantages of a nuclear law, particularly a technical law, especially where the law of a foreign country is concerned. Furthermore, reference to this foreign law and exemption of the carrier may result in denial of justice if the court subsequently dealing with the action against the operator of the nuclear installation does not consider itself to be competent. (auth)

16176 CONVENTION RELATING TO CIVIL LIABILITY IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR MATERIAL: EFFECTS OF THE NEW CONVENTION ON SPANISH LEGISLATION. Santos Lasurtegui, A. de Los; Corretjer, L. (Junta de Energia Nuclear, Madrid). pp 203-210 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In Spanish).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The implementation of the Convention concluded in Brussels on December 17, 1971 will mean the precedence of national or international nuclear legislation over existing legislation in the field of maritime carriage. As far as Spain is concerned, if international nuclear legislation were not applicable, the national nuclear legislation would be, since it meets the requirement—laid down in the Brussels Convention—of being as favorable to the victims of nuclear accidents as the Convention itself. Consequently, the effects of the Convention will be favorable, at the juridical level, because it will eliminate uncertainties regarding the rules to be applied and because, in strengthening the principles of nuclear legislation, which are the ones which should apply, it will make possible the effective protection of the victims of nuclear accidents, for although in maritime legislation the liability limit is higher than in nuclear legislation (or even unlimited), in most cases the obligation to indemnify victims arises out of liability incurred through fault or negligence, the victim having to prove that such liability exists in order to obtain indemnification. In the case of nuclear accidents, the causes of which could hardly ever be attributed to any single person, it would be very difficult for the victim to obtain indemnification for damage suffered. (auth)

16177 EFFECT OF THE NEW CONVENTION ON A COUNTRY WHICH IS NOT A PARTY TO THE PARIS CONVENTION OR THE VIENNA CONVENTION. Spingarn, E. E. (Atomic Energy Commission, Washington, DC). pp 211-216 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The effect of the new Convention on a country such as the United States of America, which is not a party to either the Vienna or Paris Convention on Third Party Liability for Nuclear Damage, is discussed. As a major international supplier of nuclear material, the United States relies to a considerable degree upon maritime carriage of such material because of its geographical location. The provisions of the Paris and Vienna Conventions are described and explained. In addition, reference is made to the recommendations of the Steering Committee of the Paris Convention and the Standing Committee of the Vienna Convention relating to extra-territorial application of the conventions. The domestic legislation of the United States relating to nuclear liability and its indemnification, the Price-Anderson Act, is also discussed in its application to transport situations of the type under consideration. In the light of these legal circumstances, advantages and disadvantages of adherence by such a country to the new convention are identified. (auth)

16178 EFFECTS OF THE NEW CONVENTION ON THE LIABILITY RULES FOR NUCLEAR DAMAGE TO THE CARRYING SHIP. Swart, P. J. (Ministry of Justice, The Hague). pp 217-221 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The effects of the 1971 Convention on the liability rules for nuclear damage to the carrying ship are not always favorable to the owner of the carrying ship. In case of collision the new convention may exonerate the owner who collides with the carrying ship. This is remarkable because he will be exonerated at the expense of the owner of the carrying ship. The words "or national law applicable in the field of maritime transport" cover the whole field of the common law of torts and exoneration therefrom in respect of liability for nuclear damage to the carrying ship is likewise detrimental to the owner of that ship. Therefore, Article 1 of the new convention does not improve the position of the carrier in respect of damage to the carrying ship, but that was not the objective of the new convention. The importance of Article 2, stating that the exoneration of any person who is liable by virtue of an international convention or national law applicable in the field of maritime transport shall also apply in respect of damage caused by a nuclear incident to the means of transport upon which the nuclear material involved was at the time of the nuclear incident and for which the operator of the nuclear installation is not liable, is very limited since it is to be expected that States will include damage to the means of transport in the liability of the operator of a nuclear installation. (auth)

16179 IMPLICATIONS OF THE NEW CONVENTION FOR THE RULES GOVERNING LIABILITY FOR NUCLEAR DAMAGE TO THE CARRIER VESSEL: A COMPARATIVE STUDY. Albano, R. (ENEL, Rome). pp 223-229 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973) (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

Under Article 3(a)(ii)2. of the Paris Convention and Article IV, 5(b) of the Vienna Convention, the operator of a nuclear installation is, in general, exempted from liability for damage to the means of transport. Nevertheless, the exemption is not in fact absolute. It can be inferred from the provisions of the two Conventions that every State has discretionary power to draw up the rules to be applied, a fact which does not contribute to unification of the law governing the case in question. Article 2 of the Brussels Convention extends the exemption from liability of any person who can be held liable under an international convention or a national law, to damage to the means of transport. It must be stressed, however, that this extension is effective only where the operator, in his turn, has been exempted from liability under the Paris or the Vienna Conventions or under similar provisions of a national law. Consequently, genuine progress beyond the earlier system can be made only when a contracting State expressly provides for exemption of the operator from liability or when it makes no provision in this regard and the Paris Convention is applicable. Failing this, the earlier system will remain unchanged without a solution having been found to the difficulties which could arise from the possibility of different persons being held liable. (auth)

16180 INSURANCE OF OPERATORS OF NUCLEAR INSTALLATIONS FOR NUCLEAR DAMAGE TO THIRD PARTIES DURING TRANSPORT. Lacroix, F. (Commission Permanente du Risque Atomique, Brussels). pp 235-239 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

Up to a certain maximum per shipment, nuclear insurers provide coverage against the financial consequences of the non-

contractual civil liability incurred by the operator of a nuclear installation in connection with damage caused by one or more nuclear incidents during the carriage of nuclear material. Such coverage, which is provided under a special transport policy or under a floating policy, can include nuclear damage to the ship. The exemption of the carrier from liability provided for in the Convention of December 17, 1971 in no way affects the liability of the operator or the insurance policy covering that liability. The entry into force of the Convention will greatly facilitate the maritime carriage of nuclear material. Certain practical difficulties remain, however; for example, the implementation of the provisions of Article 1(b) would require the setting-up of a simple system for establishing that the maritime carrier is indeed exempt from liability for nuclear damage. Ratification of the various nuclear conventions by a substantial number of countries would solve most problems. (auth)

16181 IMPLICATIONS OF THE BRUSSELS CONVENTION OF DECEMBER 17, 1971 FOR INSURANCE OF THE OPERATOR OF A NUCLEAR INSTALLATION AGAINST DAMAGE TO CARGO DURING CARRIAGE. Deprimoz, J. (Pool Francais d'Assurance des Risques Atomiques, Paris). pp 241-252 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973). (In French).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The standard circumstances, such as loading and unloading incidents, under which damage can be caused to the containment vessel of radioactive material, resulting in the contamination of other cargo and of the ship itself are discussed. It then shows that the owners of contaminated cargo can take action either against the operator-consignor or operator-consignee or against the carrier, and that the 1971 Brussels Convention, as from the date of its entry into force, will relieve the carrier of the need to insure himself directly or have himself insured under the operator's policy. It also deals with the case of grouping several nuclear consignments in one vessel and the problem of any overlapping liabilities between the operators responsible for each consignment. Lastly, it draws attention to the non-insurability of the costs and expenditure associated with the decontamination of cargo and docks, which are normally foreseeable. (auth)

16182 INSURANCE CONDITIONS IN JAPAN FOR TRANSPORT OF NUCLEAR MATERIALS AND FOR NUCLEAR SHIPS UNDER THE AMENDED JAPANESE NUCLEAR LIABILITY LAW. Masaki, M. (Japan Atomic Energy Insurance Pool, Tokyo). pp 253-267 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The Japanese legislation on nuclear third party liability was modified by an Act which came into force on October 1, 1972. The amended Japanese nuclear transport liability insurance policy takes into account these modifications. As the Act also contains provisions concerning the liability of operators of nuclear ships, an insurance policy for the operator of the N. S. "Mutsu" is being prepared. (auth)

16183 DECEMBER 1971 BRUSSELS CONVENTION AND THE NUCLEAR OPERATOR'S INSURANCE. Rand, A. C. (Marsh and McLennan, New York). pp 269-272 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The United States of America is not a Contracting State with respect to the Paris Convention and thus the 1971 Brussels Convention has no effect on the insurance purchased by the US nuclear facility operators. Within the US territorial limits the nuclear operator's nuclear liability insurance and Price-Anderson indemnity, when the latter is applicable, provide coverage for all persons with a legal liability for the nuclear accident. Specific insurance must be purchased by the US party if he wishes protection on the high seas and has no indemnification by law or by agreement from the non-US party. (auth)

16184 INSURANCE OF THE CARRIER OR SHIPOWNER FOR DAMAGE TO THIRD PARTIES (INCLUDING DAMAGE TO THE CARGO). Bradley, R. W. S. (Joint Marine Atomic Energy Committee, London). pp 273-283 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A broad outline of existing principles and practice regarding insurance of carriers or shipowners for damage to third parties (including damage to the cargo) is given. Marine underwriters can give cover limited to £5 million per voyage, when the maritime carrier has obtained an appropriate indemnity from the shipper. The new Maritime Convention of 1971 signed in Brussels, which is an attempt to solve the problems of the dual liability for a nuclear incident during transport is discussed. The effect of the Convention on the pattern of international carriage is discussed. The 1971 Convention is intended to exonerate the maritime carrier (or any person liable under Maritime Conventions). It gives priority to the Nuclear Conventions and reinforces channelling of liability on to the operator. Article 1(b) of the 1971 Convention raises many uncertainties. Problems will not be solved until all States trading in nuclear substances are parties to the Conventions, although the new Convention is a step in the right direction. (auth)

16185 LIABILITY INSURANCE COVER OF CARRIERS BY SEA OF NUCLEAR MATERIALS. Birch Reynardson, W. R. A. (British Insurers' European Committee, London). pp 285-293 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

P. and I. Clubs in 1959 excluded from their insurance policies liability for nuclear risks (except for radioisotopes). After Paris Convention P. and I. Clubs obtained from the UKAEA appropriate indemnities for the shipowner who carried fissile material and radioactive fuel and waste. Natural uranium and radioisotopes were, however, covered by the P. and I. Club policies. The indemnity from the UKAEA is now £50 million. The 1971 Brussels Convention has gone some way to reduce dual liability but there is still a residual liability on the sea carrier. Thus the position of the P. and I. Clubs is unchanged, at least until there is general ratification of the Paris and Vienna Conventions and the new Brussels Convention of 1971. (auth)

16186 THIRD PARTY LIABILITY INSURANCE OF CARRIER OR SHIPOWNER FOR DAMAGE TO THIRD PARTIES (INCLUDING DAMAGE TO CARGO). Mueller, W. (Allianz Versicherungs-AG, Munich). pp 299-301 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The operator's liability insurer is prepared to extend the third party liability insurance to the carrier or shipowner as a by-product of covering the transport liability of the operator. The scope of this extension depends on the legal regime that governs the operator's obligation to have and maintain financial security. (auth)

16187 INSURANCE AGAINST NUCLEAR DAMAGE TO THE CARRYING SHIP. Bauer, A. (Allianz Versicherungs-AG, Munich). pp 303-313 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

Information is provided for persons acting in the field of maritime carriages of nuclear substances but not professionally involved in matters of marine insurance. The principles of covering hull risks in the different market spheres are mentioned (cover against "all risks" or "named perils") with the relevant conditions and clauses cited. A special chapter deals with the problem of the application of the "causa proxima" principle in cases where both conventional and nuclear hazards contribute to loss of or damage to a ship carrying nuclear substances. The problems of the application of the "causa proxima" principle are shown up by examples of conceivable accidents in maritime carriage of nuclear substances. (auth)

16188 COMPARISON FROM THE LEGAL POINT OF VIEW. Nordenson, U. K. (Swedish Ministry of Justice, Stockholm). pp 317-349 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A study of the legal situation with respect to civil liability for nuclear damage in the field of international transport is presented. A description is given of the rules laid down in international legal instruments specifically governing civil liability for nuclear damage occurring in the course of carriage of nuclear material as well as of those rules of existing international conventions in the fields of maritime carriage, carriage by road, carriage by rail,

and carriage by air, which may be applicable when nuclear damage is caused in the course of transport of nuclear material. The four groups of interests which can be affected by nuclear damage, i.e., the means of transport itself and its equipment, goods other than the relevant nuclear material which are carried on board the same means of transport, passengers and other individuals on board the same means of transport and their luggage, and persons or property outside that means of transport are dealt with separately with respect to the different means of transport. Various international instruments are treated. On the basis of brief descriptions of the various liability systems which have been established by the conventions discussed, the report presents for each one of the transport conventions an analysis of the legal conflicts which may arise out of the simultaneous applicability of any of these conventions and any of the nuclear conventions. Finally, the report contains a proposal for a model provision to be included in future international conventions in the field of transport for the purpose of eliminating the present conflicts and with a view to bringing about uniformity with respect to the structure and scope of such provisions. (auth)

16189 COMPARISON FROM THE POINT OF VIEW OF INSURANCE. van Gijn, S. H. (Bureau van de Nederlandse Pool, Rotterdam). pp 351-356 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

A comparison from the point of view of insurance in respect of liability for nuclear damage during international transport between various types of carriage reveals that most problems for the insurers were caused by marine transport, whereas air, road and rail transport took place without serious difficulties. This probably explains why the 1971 Convention relates only to civil liability in the field of maritime carriage. Insurers welcome the new Convention, which could avoid the problems that are now sometimes experienced when a marine transport has to be carried against liability. Concerning air transport, the applicable Conventions of Rome and Warsaw do not exclude nuclear damage. However, aviation insurers are prepared within certain limits to include nuclear damage in their policies, although they maintain their right of recourse, so that a nuclear operator will have to take care to arrange for suitable cover. Railway carriage offers no trouble as the international convention concerning the carriage of goods by rail excludes nuclear damage from its field. The liability during carriage of nuclear material by road is covered by insurance but the practice is not always very satisfactory. The problems are caused, however, not by any convention in the field of transport (CMR) but by the fact that policies delivered in one country are often not accepted in other countries as transport takes place between contracting and non-contracting States. Insurers can only hope that the conventions in the field of nuclear liability will be widely ratified, which would eliminate many of the present difficulties. (auth)

16190 INSURANCE CLAUSES IN CERTAIN COUNTRIES CONCERNING THE CARRIERS' LIABILITY FOR NUCLEAR DAMAGE. Schalling, K. (Hansa Marine Insurance Co. Ltd., Stockholm). pp 359-363 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

Examples are given of nuclear exclusion clauses in insurance policies covering various liabilities of the carrier. Regarding insurance of liability for cargo in international transients governed by a transport convention the situation is the following: Sea carrier: P & I insurance, nuclear exclusion clause; air carrier: special insurance clause excluding major part but accepting nuclear damage for specified products; and road carrier: insurance of CMR liability, nuclear exclusion in most cases. Regarding third party liability, the situation is as follows: Sea carrier: Hull insurance collision liability and P & I, nuclear exclusion; air carrier: special clause; road carrier: automobile insurance, various clauses or none, liability based on national legislation. With regard to shippers' liability, there is the public liability insurance and various exclusion clauses. It is concluded that a product of a dangerous nature should bear the insurance costs for the particular protection needed. It serves no practical purposes to put an undue financial burden on the carrier. (auth)

16191 NUCLEAR THIRD PARTY LIABILITY AND INSURANCE IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR MATERIALS: PANEL DISCUSSION. pp 365-372 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The text of the questions and answers presented at a panel discussion on the third party liability and insurance in the field of maritime transport of nuclear materials is given. (RCK)

16192 CONVENTION RELATING TO CIVIL LIABILITY IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR MATERIAL. pp 375-380 of Maritime Carriage of Nuclear Materials. Vienna; International Atomic Energy Agency (1973).

From symposium on maritime carriage of nuclear materials; Stockholm, Sweden (18 Jun 1972). See STI/PUB-312; CONF-720682-.

The text of the 1971 Brussels Convention relating to civil liability in the field of maritime carriage of nuclear materials is presented. (RCK)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 16572 and 16970.

16193 (KFK-EXT-18/73-1) OPERATION OF THE KARLSRUHE ISOCHRONOUS CYCLOTRON IN 1972. Schatz, G.; Schulz, F. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Apr 1973. 13p. Dep. NTIS (U. S. Sales Only) $3.00.

The operation of the Karlsruhe Isochronous Cyclotron in 1972 is briefly reviewed. The main causes of breakdown and first results obtained with an axial injection system are discussed. The use of HfC as a cathode material in cyclotron ion sources is described. (auth)

16194 (LA-5216) H_2-ATMOSPHERE FURNACE-BRAZING AND SOLDERING-OVEN PRODUCTION OPERATION AT LAMPF. Koczan, S. P.; Rhorer, R. L.; Suazo, G.; Worstell, H. G. (Los Alamos Scientific Lab., N. Mex.). May 1973. Contract W-7405-eng-36. 26p. Dep. NTIS $4.00.

Industrial furnaces and a soldering oven were used at the linear accelerator site to assemble the side-coupled 805-MHz components on a production basis. The brazing and soldering operations required to assemble the 352 tank sections and 60 bridge tank couplers used in the 2,400 ft length of the side-coupled portion of LAMPF are discussed, step by step, including part preparation and processing. (auth)

16195 (NIIEFA-B-131) SOME RATED AND EXPERIMENTAL DATA ON DESIGN OF SYNCHROTRONS WITH STATIONARY FIELD AT ENERGY 35 TO 300 GeV. Dvoinikov, N. I.; Monoszon, N. A.; Rozhdestvenskii, B. V.; Sivkov, Yu. P.; Stolov, A. M.; Trokhachev, G. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. 9p. (In Russian). INIS.

Design data and considerations are advanced for reconstructing a synchrotron with superconducting electromagnets with stationary fields. Model accelerator experiments with such a system are described. (tr-auth)

16196 (RISO-281) ACCELERATOR DEPARTMENT ANNUAL PROGRESS REPORT, 1 JANUARY 1972–31 DECEMBER 1972. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1973. 27p. Dep. NTIS (U. S. Sales Only) $3.50.

Operation and maintenance of the irradiation facilities, radiation bacteriology research, chemical dosimetry and radiation chemistry, physical dosimetry, and irradiation technology are discussed. The staff is listed and lectures and publications are enumerated. (WDK)

16197 COMPACT ELECTRON LINAC USING SIDE-COUPLED STRUCTURE. Irie, K.; Minowa, Y.; Sawada, S. (Mitsubishi Electric Corp., Amagasaki, Japan). Jap. J. Appl. Phys.; 12: No. 2, 277-285(Feb 1973).

The design and performance of a side-coupled structure used in an electron linac are described. The high shunt impedance of 97 MΩ/m is obtained at 3 GHz. With a peak rf power of 1.4 MW and a 270 mm long structure, the peak beam current of 130 mA can be accelerated from 70 keV to 4 MeV. This means that the peak accelerating field of about 30 MV/m is stably obtained. Moreover, the diameter of the accelerated electron beam is less than 2 mm without external focusing. (auth)

16198 NANOSECOND PULSED ELECTRON SOURCE CONTROLLED WITH A MERCURY-WETTED SWITCH. Yamamoto, T.; Kawanishi, M. (Osaka Univ., Suita, Japan). Mem. Inst. Sci. Ind. Res., Osaka Univ.; No. 30, 91-96(Mar 1973).

A unique electron accelerator that can deliver a nanosecond pulsed beam has been developed. A coaxial cable of proper length is charged with a part of the accelerating voltage of the electrons through a charging resistor and then self-discharged through a mercury-wetted switch filled with high-pressure hydrogen gas. The resulting sharp pulsed voltage is applied to the grid of an electron gun. With this technique 1 nsec pulsed electron beam of 70 keV and 240 mA is obtained. (auth)

Auxiliaries and Components

16199 (LA-UR-73-882) STATUS OF LAMPF EXPERIMENTAL FACILITIES. Thiessen, H. A. (Los Alamos Scientific Lab., N. Mex.). 1973. 10p. (CONF-730642-5). Dep. NTIS $3.00.

From 5th international conference on high-energy physics and nuclear structure; Uppsala, Sweden (18 Jun 1973).

The experimental facilities which are being prepared for the Clinton P. Anderson Meson Physics Facility (LAMPF) are briefly reviewed. A status report for each beam line and experimental area is presented, and the latest estimate for the date of initial operation of each is discussed. Operating experience with the accelerator and switchyard is also reviewed. (auth)

16200 (NIIEFA-G-128) ELECTROMAGNET FEED SYSTEM DESIGN FEATURE OF PROTON SYNCHROTRON RAPID BOOSTER. Gusev, O. A.; Konstantinov, A. I.; Roshal, A. G.; Spevakova, F. M.; Stolov, A. M.; Tunkin, A. A. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 1971. vp. (In Russian). INIS.

The principles of construction are explained for a supply system for an electromagnetic rapid booster which provided a prolonged injection of particles in a proton synchrotron. Parameters of the resonance system are analyzed, and feed problems for the resonance loop are discussed. The operation of the feed system during repeated short-time regimes of excitation of the electromagnet, and methods of conserving the duration of the transition processes of a normal regime with a prescribed stability of the oscillation amplitude are discussed. (tr-auth)

16201 STUDY ON SHIELDING FOR A BETATRON. 1. Attenuation of High-Energy X Rays. Maruyama, T. (National Inst. of Radiological Sciences, Chiba, Japan); Kumamoto, Y.; Hashizume, T.; Yamamoto, M.; Mizushina, T. Shimadzu Hyoron; 29: No. 4, 255-258(Dec 1972). (In Japanese).

The broad-beam attenuation coefficients for lead, iron, heavy concrete, and ordinary concrete were determined using the x rays from a Shimadzu BT-32 betatron for the purpose of the design of the protective shielding to be placed around high-energy x-ray generators. Attenuations in these materials were measured by the ionization in a cavity in a water phantom behind these materials of various thicknesses. The variation in tenth-value thickness with field size for these materials is discussed on the basis of data obtained from the attenuation measurements. The tenth-value thickness for these materials is shown as a function of x-ray energy. (auth)

Ion Sources and Injection and Extraction Systems

16202 (CERN-73-8) STUDY OF THE PRESENT EXTRACTION SYSTEM FOR THE CERN SYNCHRO-CYCLOTRON. Lindbaeck, S. (European Organization for Nuclear Research, Geneva (Switzerland)). 19 Jun 1973. 46p. Dep. NTIS (U. S. Sales Only) $4.50.

The improvement program for the CERN 600-MeV synchrocyclotron was proposed in 1967 and authorized by CERN in November 1968. The main purpose of the program is to raise the internal beam current from the present ~1 μA to at least 10 μA. This goal is to be achieved principally by raising the acceleration voltage and by increasing the pulse repetition rate. A new ion source of hooded-arc type will be installed replacing the present "open" source. The new source, together with a new design of the dee geometry in the central region, will permit injection into well-centered orbits and, as a result, the maximum radial betatron oscillation is expected to decrease by one order of magnitude from the present 10 cm. The higher internal beam current follows a demand for greater efficiency of beam extraction, in order to keep the machine activation tolerable. The present extraction system having ≈5 to 7% efficiency, typical for synchrocyclotrons of today, is clearly insufficient. A study of the present regenerative extracter is described. The transmission properties of the extraction system are calculated as functions of betatron amplitudes, and the importance of various sources causing beam loss and energy spread in the extracted beam is discussed. The results show that the main reason for the low efficiency is the large magnetic field gradient in the vicinity of the channel wall, causing a considerable overfocussing of the beam on the last turn. The computer calculations give an efficiency of $\epsilon \approx 3\%$ for the present conditions, $\epsilon \approx 8\%$ if radial amplitudes are all less than one centimeter, and $\epsilon \approx 21\%$ if only median plane particles are present. Clearly an improvement of radial beam quality is in itself not sufficient for a substantial increase of the efficiency. (auth)

16203 (FRNC-TH-376) IMPROVEMENT OF THE QUALITY AND TIME CHARACTERISTICS OF THE POLARIZED BEAM OF THE SACLAY CYCLOTRON. Ropert, A. (Paris Univ., Orsay (France)). 1972. 93p. (In French). Dep. NTIS (U. S. Sales Only) $6.75.

Thesis.

The variable energy cyclotron at Saclay is provided with a trochoidal injection system. The theoretical and experimental aspects of the coupling between the external source of the cyclotron and the machine were studied in view of improving the characteristics of the polarized beam. The focusing and acceptance of the trochoidal system, and optimization of the optics of the focusing lenses were studied. The possibility of regrouping the particles in terms of phase at the cyclotron frequency or submultiples of this frequency was investigated. Various measurements were made on the polarized beam. (FR)

16204 IMPROVEMENTS IN OR RELATING TO ION SOURCES. (to United Kingdom Atomic Energy Authority). British Patent 1,310,397. 21 Mar 1973. Filed date 20 Oct 1970. 4p.

A factor limiting the operational usefulness of ion sources is the relatively short life of the filament, and where the source is incorporated in a pressurized machine, such as a Van de Graaff, the time lost in changing filaments is substantial. The ion source described has a sputtering electrode, from whose surface the desired ions are derived and an elongated filament juxtaposed to this surface. This filament is movable relative to the electrode surface, whereby used portions can be moved away and replaced by fresh portions. The filament may be made to ionize atoms of low pressure gas in the source which, in turn, ionize the surface atoms of the sputtering electrode. An accelerating electrode is positioned to draw ions from the region of the filament to form an ion beam. Means for storing and moving the filament are described, and also means for collecting spent filament. (UK)

16205 INJECTION AND ACCELERATION OF A 72-MEV PROTON BEAM IN THE SIN RING CYCLOTRON. Braun, H. Diss. Nr. 4593. Zurich; Eidgenoessische Technische Hochschule (1971). 120p. (In German).

Thesis.

The injection of a 72-MeV proton beam into the SIN isochronous ring accelerator can be realized by conventional injection through a magnetic and electrostatic inflector channel, or by precessional injection with a first harmonic field component and without the electric channel. The superposition of the sector field with the field of the magnetic inflector channel produces a stray field which has to be compensated within the short distance of half a gapwidth. A general design principle for such a self compensated magnetic channel is given. The acceleration of a beam centered on an equilibrium orbit produces a coherent oscillation. An ideal orbit exists which exhibits only negligible oscillations due to the energy gain. The injection path should be centered on to this orbit. The acceleration voltage varies with radius. This causes an alternating magnetic field which influences the phase width of the particle bunch. For small phase angles the phase width varies reciprocally with the accelerating voltage. The crossing of $\nu_r = 4/3$–resonance, driven by the fourth fourier component of the acceleration voltage has only negligible influence on beam quality. (auth)

16206 EXTRACTION OF A 590 MEV PROTON BEAM FROM THE SIN RING CYCLOTRON. Joho, W. Diss. Nr. 4504. Zurich; Eidgenoessische Technische Hochschule (1970). 100p.

Thesis.

A review of some basic extraction systems for cyclotrons with emphasis on conventional extraction by acceleration and resonant extraction is presented. The advantages of a ring cyclotron, i.e., large average radius, high energy gain per turn and ample space for extraction elements, are especially stressed. Detailed calculations for the SIN ring cyclotron establish an extraction efficiency of about 90%. The radioactivity induced by the lost particles gives probably an intensity limit of 100 μA for the extracted beam. Addition of a flattop cavity could give a "monoenergetic" beam and an extraction efficiency close to 100%. Special attention is given to the stability of the vertical motion since the resonances $\nu_z = 1$ and $\nu_r = 2\,\nu_z$ have to be crossed. A special chapter is devoted to resonances in coupled oscillations. (auth)

16207 BEAM POSITION MEASUREMENT DURING FAST EJECTION. Cupérus, Jan H. (CERN,1211, Genève 23, Switzerland). Rev. Sci. Instrum. 44: No. 5, 626-628 (May 1973).

A series of electrostatic pick-up electrodes is used to measure the horizontal position of a single bunch during fast ejection in the Serpukhov proton synchrotron. Any one of the 30 circulating bunches can be followed, whether it is being ejected or stays in the accelerator. The electrode signals go directly into long coaxial cables and no active components are present in the radioactive zone. The signals are digitized and go to a minicomputer. The response of the system is linear over the whole width of the electrodes (200 mm). (auth)

Ion Optics and Field Calculations

Refer also to abstracts 16409 and 16410.

16208 (UJF-2923-F) DYNAMICS OF THE MOTION OF IONS IN THE MEDIAN PLACE OF AN ISOCHRONOUS ROTATIONAL SYMMETRICAL MAGNETIC FIELD, TAKING ACCOUNT OF THE EFFECT OF THE ELECTRICAL FIELD. Kuzmiak, M.; Goloubek, I.; Grda, A. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1973. 11p. (In Russian). Dep. NTIS $3.00.

Equations are advanced for a spiral equilibrium orbit in the central plane of an isochronous magnetic field with axial symmetry. The equation of radial oscillations near the equilibrium orbit was investigated allowing for the accelerating electric field. Reference is made to the synchronous growth of the magnetic field in the median plane. (tr-auth)

16209 ELECTRON-OPTICAL DESCRIPTION OF A COMBINED WINDOW-TYPE QUADRUPOLE AND IMMERSION LENS. Horvath, L.; Kiss, I.; Koltay, E. Atomki (At. Kut. Intez.) Kozlem.; 15: No. 1, 23-39(1973). (In Hungarian).

A new type of electrostatic lens is proposed as a tool for forming line-shaped beams for high-voltage accelerators. A first order electron-optical description is also presented. (auth)

16210 DETERMINATION OF THE DISPERSION CHARACTERISTICS OF AN OPEN PERIODIC STRUCTURE USING A SINGLE IRIS VARIABLE LENGTH CAVITY. Garault, Y.; Fenelon, J. P. (Univ., Limoges, France). Compt. Rend., Ser. A, B; 276: No. 11, 409-412(12 Mar 1973). (In French).

It is shown that measurements of the π mode resonance frequency of single iris symmetric cavities having lengths satisfying the $l = kH$ relation allow the dispersion characteristics of an open structure of periodicity H to be determined. The experimental results obtained are compared with theoretical values. The method is used to study the effect of the periodicity H and the thickness of the iris on the dispersion characteristics. (FR)

16211 THIRD-ORDER TREATMENT OF COMBINED EFFECTS OF SPACE CHARGE AND EXTERNAL FIELDS ON CYLINDRICAL ION AND ELECTRON BEAMS. Bosi, G. (Université de Moncton, Moncton, New Brunswick, Canada). J. Appl. Phys. 44: No. 5, 2188-2192 (May 1973).

Analytical treatments of the space-charge spread of cylindrical beams have been based upon a number of restrictive assumptions. Most of them can be removed and a higher accuracy attained with the help of a suitable relation connecting motion and Maxwell's equations. As previous treatments appear as paraxial approximations, third-order formulas applying to arbitrary field forms have been carried out. (auth)

Storage Rings

Refer also to abstract 15630.

16212 (RL-73-30) ENERGY VARIATION FOR E-P COLLISIONS IN EPIC II. Rees, G. H. (Rutherford High Energy Lab., Chilton (England)). May 1973. 7p. Dep. NTIS (U. S. Sales Only) $3.00.

It has been suggested that the energy variation for e-p collisions should be 2 : 1 in EPIC II. The difficulties are examined. The first involves the synchronization problem between the bunched e and p beams. The second is the difficulty of providing adequate luminosity at the lower end of the energy range. A possible scheme is outlined that provides the required synchronisation for a range of centre-of-mass energies close to the proposed 2 : 1. The luminosity will fall by at least a factor of four, however, at the lower energies unless it proves feasible to increase the number of e and p bunches. The relative merits of using unbunched, in place of bunched, p beams are also considered. (UK)

16213 (RL-73-44) INITIAL STUDIES OF LONGITUDINAL SPACE CHARGE FORCES IN e-p BEAM–BEAM INTERACTIONS FOR BUNCHED AND UNBUNCHED p BEAMS. Rees, G. H. (Rutherford High Energy Lab., Chilton (England)). May 1973. 10p. Dep. NTIS (U. S. Sales Only) $3.00.

Previous publications have considered mechanisms by which the longitudinal motion of particles in storage rings is affected by the beam-beam interaction. The longitudinal component of the beam-beam force has been calculated for the case where the colliding beams have a finite crossing angle. An estimate has been made of the effect on the synchrotron motion which results from having non-zero momentum dispersion in the crossing region. A third mechanism that contributes to perturbed motion is where the large variation of beam cross-section in a so-called "low-β" in-

sertion directly leads to a longitudinal beam-beam space charge force. When using bunched p-beams, the crossing for e-p collisions may be collinear, and with zero momentum dispersion. The effect on the longitudinal motion is then confined to space charge components due to the low-β regime. The magnitude of the effects for EPIC II is discussed in the present publication. In the case of unbunched p-beams, a finite crossing angle is required for e-p collisions to minimize the long-range transverse space charge forces. There is a longitudinal space charge force on the unbunched p-beam due to the bunched electron beam, and the largest component of this force is due to the finite crossing angle. There is a re-bunching mechanism introduced on the p-beams which is analyzed. (UK)

16214 (RL-73-46) PATH LENGTH ADJUSTMENT FOR ENERGY VARIATION IN EPIC. Lewin, J. D. (Rutherford High Energy Lab., Chilton (England)). Jun 1973. 14p. Dep. NTIS (U. S. Sales Only) $3.00.

An important experimental requirement on EPIC is that it should provide, preferably at constant center of mass velocity, a range of, ideally, at least an order of magnitude in s^2 (i.e., 3 to 4 in energy). In addition, the ability to accelerate deuterons, and again provide a range of s^2, is desirable. A method of producing the requisite variation in the electron-proton path difference (up to 1 $\frac{1}{2}$ m) by introducing additional wobbles in the electron closed orbit has been suggested previously. In the present publication it is shown that the bending magnets necessary to accommodate proton momenta in the range 100 GeV/c to 30 GeV/c or less could be fitted in the available space in the long straights without increasing either the total synchrotron radiation or the peak rate of electron energy loss. The magnet system would consist of approximately 11 m of field up to $\sim 1\frac{1}{3}$ T in each of the 8 available locations, with magnet semi-apertures of about 500 mm. Modifications of these conclusions for deuterons are discussed. (UK)

16215 EXPERIMENTAL INVESTIGATION OF THE USE OF IONIZATION PRESSURE GAGES FOR LEAK DETECTION. Benvenuti, C.; Decroux, J. C. Vide; No. 162, 243-248(1972). (In French).

The method for leak detection applicable to the CERN ISR vacuum system after bakeout is described. This method, based on the enhanced indication of an ionization gauge obtained when replacing the air around the leak by argon, affords a detection efficiency not lower than that obtainable by means of a traditional leak detector, furthermore it does not introduce contamination risks after bakeout. (auth)

Experimental Facilities

16216 (BMFT-FBK-73-2, pp 80-83) GAS TARGET FOR TWO- AND THREE-PARTICLE REACTIONS. Nagel, W.; Stehle, H. Mar 1973. (In German)

16217 (LA-5307-MS) LAMPF DATA HANDLING WORKSHOP. Introduction to CAMAC. Egger, J. P. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 13p. Dep. NTIS $4.00.

A typical on-line data-acquisition system for a LAMPF beam line consists of a PDP-11 computer interfaced to the CAMAC system with a microprogrammed branch driver (MBD). This part of the LAMPF data handling workshop describes the CAMAC system. The basic features and some programming examples of CAMAC modules are given. (auth)

16218 TRITIUM AND NEUTRON PRODUCTION USING ION ACCELERATORS. Breynat, G. (CEN, Grenoble, France); Manin, A. Bull. Inform. Sci. Tech. (Paris); No. 178, 59-64(Feb 1973). (In French).

Tritium targets as they are used at present in low-energy ion accelerator producing neutrons by (d,t) reactions have a limited performance, i.e., their maximum output is about 10^{12} n/4πs and the half-life of the target is relatively short. The technical difficulties encountered in attempting to overcome these problems limit the range of applications. Nevertheless, the increased demand for fast high-intensity neutron sources, e.g., for neutron therapy, and the development of new techniques in order to meet this demand may soon lead to a renewed interest in the application of tritium. (FR)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 15547 and 16343.

16219 (AECL-4426) COSMIC RAY IGY NEUTRON MONITOR DATA. V. From Deep River, Ontario and Monthly Graphs (January 1962–December 1962). Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1973. 45p. Dep. NTIS (U. S. Sales Only) $4.25. AECL $1.50.

Uncorrected and barometer-corrected hourly rates from Deep River are given in tabular form for the period from January 1962 to December 1962. The barometer-corrected data have been normalized to remove the effects of changes of efficiency and are compatible with the results of the 48-NM-64 monitor. Graphs of the corrected data are given. (auth)

16220 (CEA-R-4441) COSMIC RAY FORMATION OF ALUMINUM 26. Tobailem, J.; de Lassus St-Geinies, C. H.; Reeves, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 15p. (In French). Dep. NTIS (U. S. Sales Only) $3.00.

Recent experimental data together with general lore on the behavior of similar spallation reactions were used to obtain full excitation curves for the formation of ^{26}Al in bombardment of magnesium, aluminium, silicon, and iron. These excitation functions were then averaged over various types of energy spectra applicable to relevant astrophysical contexts. It appears that, during galactic cosmic-ray bombardment of interstellar gas, the main contributor is silicon; while during early solar cosmic-ray bombardment of solar gas, the main contributor is magnesium, as well as during irradiation of meteoritic matter by solar and galactic cosmic rays. (auth)

16221 (COO-3080-2) HIGH ENERGY NUCLEAR INTERACTIONS WITH MATTER AND NUCLEAR PROCESSES IN NATURE. Annual Report, July 1, 1972–June 30, 1973. Schaeffer, O. A. (State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences). 1973. Contract AT(11-1)-3080. 14p. Dep. NTIS $3.00.

Proton cross sections for the production of stable rare gases in uranium and vanadium were extended to higher energies. The ^{39}Ar and ^{36}Cl content of the Benthullen meteorite was measured in order to determine its terrestrial age. Experimental procedure of the activity extraction from the FeNi-phase and the stone-phase is described. The preliminary result of 75 years is much younger than expected. A low level proportional counting system for ^{37,39}Ar and ^{36}Cl was set up. Background counting rates of 3 to 10 counts per day could be achieved. The activities are released from meteorites and targets by either vacuum melting or dissolving in new designed vacuum apparatus. (auth)

16222 (LUIP-CR-73-2) PHOTOMETRIC MEASUREMENTS ON TRACKS OF VERY HEAVY COSMIC RAY PARTICLES WITH E > 1 GeV/NUCLEON. Andersson, R.; Larsson, L.; Mathiesen, O. (Lund Univ. (Sweden). Dept. of Physics). Feb 1973. 87p. Dep. NTIS (U. S. Sales Only) $6.50.

About 120 heavy primary particles in the charge interval $16 \leq Z \leq 28$ have been identified by means of photometric measurements in a nuclear emulsion stack exposed in a high altitude balloon flight from Palestine, Texas, U. S. at 2.3 g cm^{-2} of residual atmosphere. Particles entering the detector at this site should according to earlier data be relativistic or nearly relativistic. Nevertheless, in this study it was found that a considerable part of the registered particles are nonrelativistic. The basical quantity used for charge identification was the photometrically determined track width W. To identify the nonrelativistic particles this information was combined, whenever possible, with observations of the rate of change of W along the track, $\delta W/\delta R$. A charge distribution is presented. Complete resolution between consecutive charges was not obtained. Possible sources of error are discussed with attention to the sources of error associated with measurements of $\delta W/\delta R$. A statistical model for the analysis of errors is presented. The investigation shows that combined measurements of W and $\delta W/\delta R$ can be a useful tool for identification of nonrelativistic particles. However, it also shows that this method is very sensitive to irregularities in the emulsions. This means that correct charge identification can only be obtained from flat tracks of particles passing many emulsions. The intensities at the top of the atmosphere of particles with charge numbers $16 \leq Z \leq 19$ and $20 \leq Z \leq 28$ were found to be 0.092 ± 0.012 and 0.38 ± 0.04 (m^{2}sr s)$^{-1}$ respectively. These figures are in good agreement with results obtained by Freier and Waddington in the same balloon flight. (SW)

16223 (NP-19816) EQUIPMENT AND FACILITIES AVAILABLE FOR FLYING BALLOON-BORNE SCIENTIFIC EXPERIMENTS. (Department of Supply, Mildura (Australia). Balloon Launching Station). May 1973. 41p. Dep. NTIS (U. S. Sales Only) $4.25.

The facilities at Mildura are shown and the equipment, points of contact, finance arrangements, transportation, command and tracking equipment, and insurance requirements are discussed in detail. (WDM)

16224 EXPERIMENTAL STUDY OF CERTAIN NEUTRAL COSMIC RAY INTERACTIONS. Brown, C. T. Atlanta; Georgia Inst. of Tech. (1972). 126p. University Microfilms Order No. 73-14,083.

Thesis (Ph. D.).

During the past ten years experiments performed by others have yielded results that indicate an anomalously large rate of production of muons in large volume detectors by neutral components of the cosmic radiation. A further study of this phenomenon was undertaken at Georgia Institute of Technology with particular emphasis placed on an independent confirmation of the existence of an anomaly in the rate of production of muons by neutral components of the cosmic radiation. To satisfy this objective a versatile cosmic-ray facility was designed and constructed to allow not only the confirmation of the phenomenon, but also to serve as a base for a broad range of other experiments in this area. This facility consists of a large volume, modular, liquid scintillation detection system, appropriate electronics for the collection and preliminary reduction of desired data, and liquid scintillation development and preparation apparatus. An efficient, high flash point, organic liquid scintillator was developed for use in the detector. Prior to the collection of data on neutral-particle-induced muon events, the facility was used to determine the cosmic-ray muon lifetime in mineral oil. A value of 2.13 ± 0.05 micro-seconds was obtained. Neutral-particle-induced muon lifetime data were collected for 1,802.63 hours at an average rate of 0.82 ± 0.15 events/hour. The signature of an interesting event consisted of the production of an energetic charged particle by an incident neutral cosmic ray, followed by the characteristic decay of the muon. A predicted event rate due to incident neutrons producing the $\pi-\mu-e$ decay chain within the detector was determined by applying Monte Carlo techniques to available neutron flux and cross section data and pertinent detector parameters. A predicted event rate of 1.31 ± 0.59 events/hour was calculated. The available evidence indicated that the sea level cosmic-ray neutron intensity is sufficient to account for the observed neutral-particle-induced muon rate in the detector. It is pointed out, however, that the errors in the two rates allow for up to 25% of the events to be due to processes other than pion production by incident neutrons. In conclusion, no obvious anomaly in the rate of production of muons by neutral components of the cosmic radiation was observed. (TSS)

16225 CALCULATION OF THE STOPPING MUON RATE UNDERGROUND. Cassiday, G. L.; Keuffel, J. W.; Thompson, J. A. (Department of Physics, University of Utah, Salt Lake City, Utah 84112). Phys. Rev. D 7: No. 7, 2022-2031 (1 Apr 1973).

A detailed calculation is given for the rate of stopping cosmic-ray muons underground. An important source of such muons, dominant at depths $\gtrsim 1.5\times10^5$ g/cm^2, is the decay of slow pions which are the end products of hadronic cascades in the rock initiated by the photonuclear interactions of fast muons. The cross section for the production of such cascades is obtained by extrapolating accelerator data to higher energies. The multiplicity of stopping pions is taken from a detailed Monte Carlo calculation. The results agree with the observed rate of stopping muons and of identified stopping pions at shallow depths. An explanation is offered for the Turin measurements of stopping muons made at shallow depths and various inclined zenith angles. However, for the Turin point at 4.27×10^5 g/cm^2 (which is uniquely sensitive to a possible anomalous source of stopping muons) the predictions fall short by a factor 4, and we are unable to account for the discrepancy even under the most extreme assumptions for the conventional processes considered. (auth)

16226 STOPPING PIONS IN HIGH-ENERGY NUCLEAR CASCADES. Jones, W. V.; Johnson, D. P. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803); Thompson, J. A. Phys. Rev. D 7: No. 7, 2013-2021 (1 Apr 1973).

Results of Monte Carlo calculations for the number and energy

spectra of charged pions from nuclear-electromagnetic cascades developing in rock are presented for primary hadron energies ranging from 3 to 3000 GeV. These spectra are given as functions of the longitudinal depth in the absorber and the lateral distance from the cascade axis. The number of charged pions which stop in the absorber increases with the primary energy of the hadron initiating the cascade. Knowledge of the $\pi-\mu-e$ decays from stopping pions is necessary to interpret certain underground experiments on cosmic-ray muons. Detection of delayed electrons from such decays could be used to estimate primary hadron energies with normal standard deviations ranging from ≈66% at 3 GeV to ≈30% at 3000 GeV. (auth)

16227 ORIGIN OF COSMIC RAYS: NEW INTEREST IN AN OLD QUESTION. Grewing, M. (Univ., Bonn); Heintzmann, H. Z. Naturforsch., a; 28: No. 3-4, 369-376(1973).

After briefly reviewing the experimental facts that seem of direct relevance for the question of the origin of cosmic rays, and after quickly going through the "classical" theories of cosmic-ray origin those theories that have been put forward over the past few years since the discovery of pulsars are discussed. This discovery brought the first observational evidence for the existence of super-strong magnetic fields in nature. (GE)

16228 PERIODIC VARIATIONS OF THE COSMIC RADIATION. 3. 27-Day Variation. Messerschmidt, W. (Martin Luther Univ., Halle-Wittenberg, Ger.). Planet. Space Sci.; 21: No. 7, 1141-1150(Jul 1973).

The relation between the 27-day variation of the cosmic radiation and of the terrestrial horizontal magnetic intensity has been investigated by means of the data recorded from 1957 to 1968. The periods have a correlation of about +0.5. The cosmic radiation is undoubtedly modulated by the Sun. A persistent wave with a periodicity of approximately 27.2 days could be proved from the data of several ion chamber and neutron monitor stations, but not underground (14m w.e.). The frequency of the daily period of the cosmic radiation shows a 27.3 day variation, too. The sum total of the relative sunspot numbers has a period length of 27.4 days. Their connection with the cosmic radiation is discussed. (auth)

16229 ABSOLUTE INTENSITY OF MUONS AT 31.6 hg cm^{-2} BELOW SEA LEVEL. Crookes, J. N.; Rastin, B. C. (Univ. of Nottingham, Eng.). Nucl. Phys.; B58: No. 1, 93-109(1973).

The absolute intensity of muons was measured at a vertical depth of 31.6 hg cm^{-2} below sea level using a telescope which consisted of two arrays of crossed neon flash tube detectors triggered by a fourfold Geiger counter coincidence. The use of flash tubes to delineate the particle's trajectory allowed unambiguous identification of single particle traversals as well as enabling the acceptance solid angle to be defined with an error of only 0.5%. All triggering particles were required to traverse 10.3 cm of lead which together with all other material in the telescope provided an absorber thickness of 134 ± 1 g cm^{-2} giving a total depth below the top of the atmosphere of 43.0 ± 1 hg cm^{-2}. The intensity measurements were performed with the axial direction of the telescope in the vertical direction and at zenith angles of 30, 45 and 60° in the N-S azimuth. These measurements together with those of other workers were used in the determination of a depth intensity curve. Sea-level spectra for vertical incidence as well as for zenith angles of 30, 45, and 60° were derived using the equation which represents the diffusion of particles through the earth's atmosphere. These spectra normalized to the sea-level results reported previously by Crookes and Rastin were used with the measurements made at the underground site to give a range-energy relationship. This relationship was compared not only with the theoretical predictions but also with the measurements of Appleton et al., which can be used to provide a range-energy relationship by utilizing the depth-intensity curve obtained in this work. (auth)

16230 MEASUREMENT OF THE CHEMICAL COMPOSITION OF LOW ENERGY COSMIC-RAY PARTICLES OF CHARGES FROM Z = 12 UP TO Z = 28 USING PLASTIC DETECTORS. Bartholomae, K. P.; Enge, W.; Fukui, K. (Univ., Kiel). Z. Phys.; 259: No. 1, 75-99(1973). (In German).

From spring meeting of the Arbeitsgemeinschaft Extraterrestrische Physik; Bonn, Germany (15 Mar 1972).

Results of a balloon flight experiment flown from Fort Churchill, Canada, at 1.8 g/cm^2 for about 10 hr in 1968 are presented. The study was made using Lexan polycarbonate plastic sheets as a particle detector. The analysis of the flux and the charge composition is based on the measurement of 313 stopping particles from Mg to Ni with energies between 150 and 400 MeV/N. The identification of the tracks of the particles is achieved using the restricted energy loss criterion. The charge of a particle could be measured with an accuracy of ±0.3 charge units in the region of the iron peak. The even Z to odd Z ratio for charges Z ≥ 20 is 3. The ratios of Mn/Fe = 0.34, Cr/Fe = 0.42, and Ca + Sc + Ti/Fe = 1.05 were measured. From these measured charge ratios a thickness of (3 ± 1) g/cm^2 interstellar matter was deduced. (GE)

16231 COSMIC RADIATION AND CONCORDE. Delahaye, R. P. (Hopital d'Instruction des Armees Begin, Saint-Mande, France). Aeronaut. Astronaut. (Paris); No. 40, 5-9(Mar 1973). (In French).

The SST medical board has been in charge of the cosmic radiation problem since 1963. Measurements made from prototypes indicate dose rates of between 0.4 and 1.7 mRem/flight hour according to the latitude. The relation between solar flares and radioactivity was studied in detail. Only a very small percentage of these flares can have any effect at the altitude flown. It is extremely unlikely that any radiobiological damage could be caused by such small doses. (FR)

16232 CHEMICAL COMPOSITION OF THE COSMIC RADIATION AND THE PROBLEM OF LARGE TRANSVERSE MOMENTA. Aschenbach, B. (Univ., Tuebingen, Ger.). Atomkernenergie; 20: No. 3, 182-186(1972). (In German).

A report is given on investigations which were performed within the air shower group at Kiel in order to clarify the problems of the behavior of the transverse momentum in strong interactions at high energies and of the chemical composition of the cosmic radiation at energies above 10^{14} eV. (GE)

16233 COSMIC RADIATION AND RESEARCH UNDERTAKEN ON BOARD A 001 PROTOTYPE CONCORDE. Delahaye, R. P. (Hopital d'Instruction des Armees Begin, Saint-Mande, France); Kaiser, R.; Francois, A.; Portal, H. Rev. Med. Aeronaut. Spatiale; No. 43, 143-150(1972). (In French).

During test flights of the French Concorde prototype, no significant solar flares occurred. The average dose rate due to galactic cosmic radiation at the cruising altitude is 1 mRem/h, the local value varying between 0.5 and 1.1 mRem/h depending upon the geomagnetic latitude. The same observations were made during test flights with the English 002 prototype. New test trials will be undertaken during 1972/1973. (FR)

16234 METHOD FOR THEORETICAL DETERMINATION OF SOME CHARACTERISTICS OF ELECTRON COMPONENT OF THE EXTENSIVE AIR SHOWERS. Popova-Grueva, L. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk.; 23: 5-13(1973). (In Russian).

An analysis of the accepted models for development of extensive air showers (EAS) is carried out. These models are based on the information obtained from experiments with accelerators for elementary particle interaction and on the results from complex investigations on the EAS of different groups. Analytical methods and Monte Carlo method for simulation of the EAS are presented. Calculations are made with computer. A method for solution of the diffusion equations of pions and for calculation of the electron component characteristics, which are measured with equipment for EAS, is shown. The considered method is necessary for obtaining results concerning some parameters of the elementary interactions at energies over 10^{14} eV such as the multiplicity of the secondary particles, their energetic spectrum, the transverse momentum spectrum, etc. Methods, used by other authors, for theoretical investigation of the electron component of the EAS, are surveyed. (auth)

16235 PARTICLE TRACK RECORD OF THE LUNA MISSIONS. Comstock, G. M.; Fleischer, R. L.; Hart, H. R. Jr. (General Electric Research and Development Center, Schenectady, NY). Moon; 7: No. 1-2, 76-83(1973).

Measurements are reported of particle-track densities in 100 to 200 μ crystalline grains taken from one level of the soil column returned from the lunar highlands between Mare Fecunditatis and Mare Crisium by Luna 20 and from two levels in that from Mare Fecunditatis by Luna 16. Ninety-three percent of the grains from Luna 16 have very high densities, $>10^8$ cm^{-2} and the lower-track density grains are all in the deeper soil level. In contrast, most Luna 20 grains show densities $<10^8$ cm^{-2}. Track density gradients and exposure times have been measured from six Luna 16 grains with a wide spread in absolute track densities. The more extensive track counts in crystals strengthens an earlier conclusion that the Luna 16 soil has received long irradiations very close to the surface. Two possible histories are that the highly irradiated soil blanket at the Luna 16 site is either well mixed and thin, or else has accumulated by transport from surrounding higher regions. The single sample of doubtful depth from Luna 20 shows a much lesser near-surface irradiation, giving results similar to those on the Apollo 12 core and the 54–80 depth sample from the Apollo 15 deep core. (auth)

16236 A RIGOROUS COSMIC-RAY TRANSPORT EQUATION WITH NO RESTRICTIONS ON PARTICLE ENERGY. Klimas, A. J.; Sandri, G. (Aeronautical Research Associates of Princeton, Inc.,

Princeton, New Jersey 08540). Astrophys. J. 180: No. 3, 937-954 (15 Mar 1973).

A new transport equation for the cosmic-ray omnidirectional intensity is obtained. This equation follows exactly from the coupled pair of differential moment equations we presented earlier. It can be characterized as a nonlocal convection–diffusion equation in which the usual transport coefficients are replaced by time integral operators. The nonlocal equation is shown to reduce to the standard convection–diffusion form if the adiabatic approximation can be applied. In general, the adiabatic approximation does not apply; however, by going to the limits of infinite and zero gyroradius and, in addition, applying the adiabatic approximation, the large- and small-gyroradius transport theories due originally to Jokipii are regained. The validity of these theories as asymptotic limits and as approximate theories in the interplanetary magnetic field is discussed. It is concluded that the small-gyroradius limit cannot be considered an approximate theory for low-energy particles even when the random field strength is weak. In addition, by scaling the length and time appropriately, a low-energy scaling law is derived. This law can be used to obtain low rigidity solutions to the nonlocal convection–diffusion equation. Thus, the nonlocal convection–diffusion equation can be used to study solar-modulation or solar-particle event phenomena down to arbitrarily low rigidities, provided the particle distribution function is nearly isotropic. (auth)

16237 A MEASUREMENT OF COSMIC-RAY RIGIDITY SPECTRA ABOVE 5 GV/C OF ELEMENTS FROM HYDROGEN TO IRON. Smith, L. H.; Buffington, A.; Smoot, G. F.; Alvarez, L. W. (Space Sciences Laboratory, University of California, Berkeley); Wahlig, M. A. Astrophys. J. 180: No. 3, 987-1010 (15 Mar 1973).

This paper presents measurements of the differential rigidity spectra of primary cosmic-ray nuclei between 5 GV/c and 100 GV/c. These measurements were performed with a balloon-borne superconducting magnetic spectrometer containing scintillation detectors, optical spark chambers, and associated electronics. We present a rigidity spectrum for each element from hydrogen through oxygen and for groups of elements through the iron group. In our data, at large rigidities, the elements lithium, beryllium, boron, and nitrogen become increasingly rare relative to the other elements. Since these four elements are thought to be fragmentation products from the interactions of carbon, oxygen, or heavier cosmic-ray elements with the interstellar gas, one possible explanation of this result is that less interstellar material was traversed by higher-rigidity nuclei in the cosmic rays. (auth)

Stars

Refer also to abstracts 16298, 16338, and 17062.

16238 STANDING PION WAVES IN SUPERDENSE MATTER. Sawyer, R. F.; Yao, A. C. (Department of Physics, University of California, Santa Barbara, California 93106). Phys. Rev. D 7: No. 6, 1579-1586 (15 Mar 1973).

Previous results for the ground-state energies of systems of nucleons interacting with a condensed running-wave mode of π^- mesons are extended to the case of standing-wave modes. The onset density of the condensation turns out to be the same as in the running-wave case; at higher densities the standing-wave case has a somewhat lower energy, at least in the case in which ordinary nuclear forces are not taken into account. There are reasons to believe that the effects of these nuclear forces on the condensation will be much greater for the standing-wave case than for the running-wave case. The possibilities of π^+ and π^0 condensation are discussed. (auth)

16239 PHOTONEUTRINO ENERGY LOSSES IN STRONG MAGNETIC FIELDS. Canuto, V. (Institute for Space Studies, Goddard Space Flight Center, NASA, New York,10025); Fassio-Canuto, L. Phys. Rev. D 7: No. 6, 1601-1608 (15 Mar 1973).

The energy losses by photoneutrinos is computed in the presence of a magnetic field of 10^{10} G, typical of neutron stars. Plasma effects are not included. The results indicate that for $T \geq 10^8$ °K and densities $\rho \geq 10^4$ g/cm³, the presence of a strong H field decreases the energy losses by at the most a factor between ten and a hundred in the region up to $\rho \simeq 10^6$ g/cm³. At higher densities the neutrino emissivities are almost identical. These effects are temperature-dependent and they are less pronounced when $T \geq 5 \times 10^8$ °K. (auth)

16240 PAIR ANNIHILATION INTO NEUTRINOS IN STRONG MAGNETIC FIELDS. Canuto, V. (Institute for Space Studies, Goddard Space Flight Center, NASA, New York, New York); Fassio-Canuto, L. Phys. Rev. D 7: No. 6, 1593-1600 (15 Mar 1973).

The production of a pair of neutrinos via annihilation of an electron and positron is computed in the presence of a strong magnetic field typical of neutron stars. The results are compared with the zero-field case, and it is shown that the neutrino luminosity Q(H) is greater than Q(O) for temperatures up to $T \simeq 3 \times 10^8$ °K and densities up to 10^6 g/cm³. For temperatures exceeding $T = 3.85 \times 10^8$ °K $Q(H) < Q(O)$ at any density. Since it was previously established that electromagnetic losses are systematically enhanced, the thermal history of the star will therefore result from a delicate balance between electromagnetic and neutrino energy losses. (auth)

16241 RADIATION ACCELERATION OF A GAS IN THE ATMOSPHERES OF STARS. Konyukov, M. V.; Malov, I. F. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 188-193(1972). (In Russian).

The acceleration of a gas by a mechanism of radiative heat conductivity was examined. Parameters which determine the character of the solutions of the investigated system were isolated. Observed values for these parameters are adduced for stellar atmospheres of the main sequence and of Wolf–Rayet stars. It is shown that the system under investigation does not possess solutions which describe the observed properties of the currents of stellar gas. The radiative heat conductivity may play a role only in the preliminary acceleration of gas up to the velocities near the speed of sound. (tr-auth)

16242 ACCEPTED TYPES OF STELLAR PLASMA ATMOSPHERES. Konyukov, M. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 3-19(1972). (In Russian).

The use of equations for spherical-symmetrical stellar atmospheres in a hydrodynamic approximation leads to valid types of plasma atmospheres. Criteria of the validity are discussed relative to the formation of turbulent states and the applicability of hydrodynamic models. (tr-auth)

16243 RADIATION-INDUCED ACCELERATION OF GAS IN STELLAR ATMOSPHERES. Malov, I. F. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 33-41(1972). (In Russian).

The essential role of radiation in the dynamic phenomena occurring in the atmosphere of a star is discussed. A system of equations of radiation gas dynamics is derived which shows that under the conditions of a stellar atmosphere an entire series of small parameters apply. A null approximation for these parameters is examined—a polytropic approximation; its applicability to the atmospheres of OB-supergiants in Wolf–Rayet stars. (tr-auth)

16244 A THEORETICAL MODEL FOR TYPE II SUPERNOVAE. Falk, Sidney W.; Arnett, W. David (Department of Astronomy, University of Texas at Austin). Astrophys. J. Lett. 180: No. 2, L65-L68 (1 Mar 1973).

Numerical calculations of shock waves in extended circumstellar envelopes, with radiation transport via photon diffusion, have been performed; they suggest a satisfactory explanation for the light curves of (at least) Type II supernovae. This model predicts the development of a severe Rayleigh–Taylor instability after peak light, and also predicts the presence of high- and low-density phases in the expanding matter. (auth)

16245 CPD-31°1701, AN EXTREMELY HELIUM-RICH, SUBLUMINOUS, O-TYPE STAR. Garrison, R. F. (David Dunlap Observatory, University of Toronto, Richmond Hill, Ontario); Hiltner, W. A. Astrophys. J. Lett. 179: No. 3, L117-L120 (1 Feb 1973).

The spectrum of CPD-31°1701 is completely dominated by lines of neutral and ionized helium, most of which are extremely Stark-broadened. The spectral type is O8, and the photometric results are: $V = 10.52$, $B-V = -0.31$, and $U-B = -1.17$. The absolute magnitude is fainter than $M_V = 0$ and probably $+3$. (auth)

16246 POSSIBLE EXPLANATION FOR NONTHERMAL RADIO NOISE FROM BINARY STARS. Jones, T. W.; Woolf, N. J. (School of Physics and Astronomy, University of Minnesota, Minneapolis). Astrophys. J. 179: No. 3, 869-873 (1 Feb 1973).

Radio emission from the binary stars α Sco, β Per, and β Lye is interpreted as due to the mass exchange between the components. The electrons in the inflowing stream excite plasma waves near the surface of the receptor star, and these waves generate radio emission. Crude predictions of radio frequency, intensity, and timescales of variation seem compatible with current observations. (auth)

16247 NEW SOUTHERN PLANETARY NEBULAE. van den Bergh, Sidney; Racine, René; van Agt, Steven; Barnes, Thomas; Coutts, Christine; (and others) (David Dunlap Observatory, University of Toronto Richmond Hill, Ontario, Canada). Astrophys. J. 179: No. 3, 863-863 (1 Feb 1973).

Seven new planetary nebulae have been found during a two-color survey of the Southern Milky Way. (auth)

16248 FOUR-COLOR OBSERVATIONS OF EARLY-TYPE STARS. I. STANDARDS AND SECONDARY STANDARDS. Philip, A. G. Davis; Philip, Kristina D. (Dudley Observatory and State University of New York at Albany). Astrophys. J. 179: No. 3, 855-861 (1 Feb 1973).

Four-color observations have been made of 39 standard and 42 secondary standard stars of spectral types O9 to K3. Each standard has been observed an average of 34 times, each secondary standard an average of 32 times. The zero point errors of the indices b–y, c_1, and

m_l are +0.001, -0.002, and 0.000 mag, respectively, relative to the published values of Crawford and Barnes. Most of the secondary standards are fainter than V=6.0 mag and are intended for use with large telescopes. (auth)

16249 THE PRODUCTION OF DISCRETE, QUANTIZED OUTFLOW VELOCITIES BY RADIATION PRESSURE IN STARS, SEYFERT NUCLEI, AND QUASI-STELLAR OBJECTS. Scargle, Jeffrey D. (Lick Observatory, Board of Studies in Astronomy and Astrophysics, University of California, Santa Cruz). Astrophys. J. 179: No. 3, 705-719 (1 Feb 1973).

A number of stars, Seyfert galaxies, and quasi-stellar objects are ejecting gas at discrete velocities which, in some cases, form arithmetic sequences. This mass loss is probably driven by radiation pressure; the discreteness and ordered velocity structure can be understood as the result of the presence of opacity in closely spaced pairs of lines. The value of the "quantum" of velocity in a number of specific cases predicted by the theory is in good agreement with the observations. (auth)

16250 STELLAR AND INTERSTELLAR K LINES: GAMMA PEGASI AND IOTA HERCULIS. Hobbs, L. M. (Yerkes Observatory, University of Chicago). Astrophys. J. 179: No. 3, 823-826 (1 Feb 1973).

High-resolution scans show that the relatively strong (≈90 mÅ) K lines of Ca II in the early B stars γ Peg and ι Her are almost entirely stellar in origin, although the latter case includes a small interstellar contribution. Such stellar lines can be of great importance in augmenting the interstellar absorption, up through the earliest of the B stars. (auth)

16251 ANALYSES OF LIGHT-ION SPECTRA IN STELLAR ATMOSPHERES. III. NITROGEN III IN THE O STARS. Mihalas, Dimitri (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado); Hummer, D. G. Astrophys. J. 179: No. 3, 827-845 (1 Feb 1973).

An analysis of the N III emission lines in O stars has been carried out on the basis of a detailed solution of the coupled statistical-equilibrium and transfer equations for a multiline, multilevel, multi-ion ensemble. Our calculations, using static, plane-parallel models reproduce successfully the observed emission at λλ4634, 4640, 4641 ($3p\ ^2P^0$–$3d^2D$) and absorption at λλ4097, 4103 ($3s\ ^2S$–$3p^2P^0$). The $^2P^0$—^2D multiplet is found to come into emission at the observed temperature for both main-sequence and low-gravity objects. The equivalent widths of the emission lines agree very well with those measured for the class of Of stars thought to have compact atmospheres, i.e., those classified as O((f)) by Walborn. In these stars the basic physical mechanism responsible for this phenomenon is the overpopulation of 3d by means of dielectronic recombinations from the low-lying $2s2p(^1P^0)3d$ autoionizing states with cascades 3d–3p. The 3p state is drained by the "two-electron jumps" coupling 3p to the $2s2p^2(^2S, ^2P, ^2D)$ states, thus preventing emission in the 3s–3p lines. The possible importance of the Swings mechanism to the fully developed Of stars (in Walborn's sense) is pointed out, and the irrelevance of the Bowen mechanism to all Of stars is firmly demonstrated. The fact that the N III emission lines can be produced in static nonextended atmospheres in radiative equilibrium has the far-reaching significance that the presence of emission lines in a spectrum is not in itself sufficient evidence for the existence of a stellar chromosphere (i.e., an extended, nonradiatively heated region). (auth)

16252 A YOUNG STELLAR GROUP IN THE VICINITY OF R CORONAE AUSTRINAE. Knacke, R. F.; Strom, K. M.; Strom, S. E.; Young, E. (State University of New York at Stony Brook); Kunkel, W. Astrophys. J. 179: No. 3, 847-854 (1 Feb 1973).

Infrared and optical observations are presented for 11 stars in the dark cloud located near the well-known emission-line variable R CrA. Many of these objects are found to have significant infrared excesses suggesting the presence of circumstellar envelopes. The age of the group is probably less than 10^6 years. Most of these stars are T Tauri-like objects with a range of masses between 1 and 4 $M_\odot$, very similar to the mass range deduced for such objects in the Taurus clouds. The infrared properties of these stars suggest that the R CrA group is somewhat younger than T Tauri stars in other young stellar groups. (auth)

16253 MONTE CARLO RADIATIVE-TRANSFER SOLUTIONS FOR COOL STELLAR PHOTOSPHERES. Sandford, Maxwell T. II (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico); Pauls, Thomas A. Astrophys. J. 179: No. 3, 875-883 (1 Feb 1973).

Numerical evaluations of the exact solution for the uniformly emitting, Rayleigh scattering, conservative, plane-parallel, finite atmosphere are presented for optical thicknesses τ_1=0.20, 1.00, and 2.00, and are used to evaluate the precision of solutions made with adjoint Monte Carlo method. The inadequacy of the single-scattering approximation is shown for optical thicknesses $\tau_1 \geq 0.2$. This method is employed to calculate the limb darkening and polarization produced by Rayleigh scattering in an M-star model atmosphere, at four wavelengths. The result of Chandrasekhar lies between those obtained for λλ4560 and 5520. (auth)

16254 Hα EMISSION-LINE STARS IN THE LARGE MAGELLANIC CLOUD: A NEW SURVEY WITH PHOTOGRAPHIC PHOTOMETRY. Bohannan, B. E. Los Angeles; Univ. of California (1973). 146p. University Microfilms Order No. 73-13,128.

Thesis (Ph. D.).

The brightest stars in the Large Magellanic Cloud (LMC) are over-luminous ($M_{bol} \sim -10$) supergiants exhibiting P Cygni-like emission characteristics. In this dissertation the LMC was surveyed for stars with Hα in emission, the first symptom of mass-loss observable in the visible. Two epochs of objective prism plates, 1968 and 1970, were surveyed to obtain a complete survey to R = 14.5. The survey is complete to an estimated 90 per cent at R = 15.5. The survey yielded 625 stellar-like objects in the Large Cloud with Hα in emission. Photographic photometry of the survey stars is included to define the domain in the color–magnitude diagram occupied by the Hα emission-line stars. The observed distribution of color-index, B-V, is wide. This results from imprecision in determination of the field effects of the photographic photometry, rather than from an intrinsic property of the survey stars. The survey stars are compared with various groups of stars in the Galaxy and in the LMC with respect to their color–magnitude diagrams and to their luminosity functions. The number of 20 to 60 solar mass stars identified from theoretical stellar evolution tracks to be in the phase of core hydrogen burning is small compared with that number identified to be in the later phases of stellar evolution. This result suggests that the pathological supergiants develop Hα emitting atmospheres as a byproduct of stellar evolution, rather than possessing them as an artifact of star formation. The yellow and red supergiants occupy that region of the color–magnitude diagram where massive pre-main sequence stars should be found. (TSS)

16255 DETAILED ANALYSIS OF THE CHEMICAL ABUNDANCES FOR THE STAR THETA URSAE MAJORIS. Weems, M. L. B. Stillwater, OK; Oklahoma State Univ. (1972). 169p. University Microfilms Order No. 73-15, 275.

Thesis (Ph. D.).

Spectral synthesis of selected absorption lines in the spectrum of theta Ursae Majoris was performed using a detailed model atmosphere technique. The best compromise between the hydrogen line profiles and the multi-color and UBV photometry was an Elste solar-type model with an effective temperature of 6350°K and surface gravity of 4.0 dex. A scaled solar temperature distribution was utilized for the computations of the opacity, gas, and electron pressure as functions of the optical depth at 5000 Å. (TSS)

16256 INVESTIGATION OF STELLAR POPULATIONS AMONG G AND K GIANT STARS. Janes, K. A. New Haven; Yale Univ. (1972). 206p. University Microfilms Order No. 73-14,343.

Thesis (Ph. D.).

Intermediate-band photometry on the DDO system was used to investigate cyanogen band strengths in a large sample of bright G and K giant stars and in stars on the giant branches of the open clusters M67 and NGC 7789. The photometry was calibrated to yield a surface-gravity-independent index of CN strength and an estimate of the absolute magnitude. In the course of deriving the absolute magnitude calibration, the relation between the width of the K-line emission and absolute magnitude was found to be nonlinear; a recalibration of this relation was derived. Based on the CN strengths of cluster giants, M67 is not super-metal-rich, but has approximately solar composition, i.e., it is metal-poor with respect to the Hyades. No evidence was found in either cluster for intrinsic differences in the CN strengths among stars on the giant branch or clump. The reddenings found for the clusters were 0.05 and 0.30 m for M67 and NGC 7789, respectively, and the distance moduli obtained were m-M = 9.33m for M67 and m-M = 11.13m for NGC 7789. The fact that these values agreed with previous estimates demonstrated the validity of the absolute magnitude calibration. Published UBV, proper motion and radial velocity data were used with the DDO photometry to obtain space velocities for 799 stars. Analysis of the velocities showed that there is a radial composition gradient in the disk of the galaxy, in the sense that the mean value of the CN index, σCN, is found to increase inwards by 0.005m/kpc. The velocity data also confirmed that the interstellar medium has been enriched with heavy elements over the lifetime of the galactic disk. (Diss. Abstr. Int., B)

16257 THEORETICAL INTERPRETATION OF EMISSION SPECTRA OF WR STARS. II. Calculation of the Probabilities of the Forbidden Transitions $2p^2\ ^1SD$–$2s2p^3P$ in the Spectra of the Ions BeI, BII, CIII, NIV, ..., PXII. Nikitin, A.; Feklistova, T.

(Leningrad State Univ.). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 22: No. 2, 164-172(1973). (In Russian).

The probabilities of the intercombination lines $2p^2\ ^1SD-2s2p^3P$ in the spectra of the isoelectronic sequence BeI, BII, CIII, NIV, ..., PXII were determined. These lines appear as a result of the spin-orbital interaction and violence of the LS-coupling. The interaction of configurations of the upper and lower levels was taken into account. The radial integrals for BeI–OV were taken from Yutsis, et al. (1961) and Kelly (1964), and for FVI–PXII were calculated by a semi-empirical method. The role of the spin-orbital interaction increases from BeI to PXII. (auth)

16258 PINCH INSTABILITIES IN MAGNETIC STARS. Wright, G. A. E. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 339-358(1973).

It is suggested that hydromagnetic "pinch" instabilities are capable of efficient magnetic flux destruction in the early stages of a star's history. The stability of an axisymmetric magnetic field in the convectively stable region of a star is investigated. It is found that a purely poloidal field is unstable to the kink instability, but that a mixed poloidal–toroidal field may be stable if the toroidal component is sufficiently large. One condition necessary for a star to be magnetic could therefore be the presence of a toroidal field strong enough to prevent instability. (auth)

16259 SPECTRAL LINE FORMATION IN EXTENDED ATMOSPHERES. II. Peraiah, A. (Tata Inst. of Fundamental Research, Bombay). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 321-327(1973).

Line profiles have been computed for a model of two-level atom both for plane parallel and spherically symmetric geometry assuming both LTE and non-LTE. (auth)

16260 INNER-SHELL IONIZATIONS IN THE INTERSTELLAR MEDIUM. Weisheit, J. C. (Univ. of California, Livermore). pp 363-375 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Some of the physical processes discussed that must be considered for a correct interpretation of observations of the interstellar medium by satellite-born ultraviolet spectrographs are: namely, effects on the ionization equilibria of interstellar carbon, nitrogen, and oxygen that result from inner-shell ionization and subsequent transitions. The relevance of these processes to the understanding of spectra of various types of astronomical objects is noted. (JFP)

16261 RELATIVE IMPORTANCE OF RAYLEIGH SCATTERING BY ATOMS AND NEGATIVE ION ABSORPTION IN THE ATMOSPHERES OF LATE-TYPE STARS. Tarafdar, S. P.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 299-305(1973).

The Rayleigh scattering by He, C, and N has been compared with the absorption by negative ions and with electron scattering and has been found to be important at temperatures and pressures appropriate to the atmospheres of late-type hydrogen deficient giant and supergiant stars. (auth)

16262 NONSTATIC SCHWARZSCHILD MODEL OF A STAR. Ross, James A. (Institute for Defense Analyses, Systems Evaluation Division, Arlington, Virginia 22202). Phys. Rev. D 7: No. 8, 2331-2332 (15 Apr 1973).

The relativistic Schwarzschild model of a static spherically symmetric star of uniform density is extended to the case in which the star is allowed to expand or contract. It is shown that the velocity of expansion or contraction of such a star obeys a law of the form $v=Hr$, where r is the distance from the center. It is further shown that all homologous perturbations of such a star lead either to infinite expansion or to gravitational collapse. (auth)

16263 EVOLUTION OF STARS WITH SUPPRESSED CORE CONVECTION. Stothers, Richard; Chin, Chao-wen (Institute for Space Studies, Goddard Space Flight Center, NASA). Astrophys. J. 180: No. 3, 901-905 (15 Mar 1973).

Stellar evolution on the upper main sequence has been computed for models of stars with cores assumed to be in radiative equilibrium, up to the point of central helium ignition. The role of the Schönberg–Chandrasekhar limit for an isothermal core is found to be critical for the evolutionary tracks. Observational data are used to rule out the hypothesis of evolution with radiative cores (in upper main-sequence stars) and, by implication, of magnetic fields that are sufficiently strong to have suppressed the core convection. (auth)

16264 NEUTRINO-PAIR EMISSION IN DENSE MATTER: A MANY-BODY APPROACH. Flowers, Elliott (Department of Physics, University of Illinois, Urbana). Astrophys. J. 180: No. 3, 911-935 (15 Mar 1973).

We formulate the description of neutrino-pair emission in dense matter in terms of the correlation functions of the background matter, and consider in detail, at densities and temperatures expected for neutron stars, the neutrino-pair bremsstrahlung emission from electrons in a static lattice and the one-phonon corrections to this process. The one-phonon corrections are important for temperatures greater than the Debye temperature of the lattice and become as large as the static lattice contributions near the melting temperature of the lattice. However, when the one-phonon contributions are of most importance, the plasma neutrino process is usually the dominant mechanism of energy loss. The decay of multiphonon states into neutrinos is also considered, and we find this process to be negligible for acoustic phonons due to phase-space restrictions. At high densities ($\rho \approx 10^{14}$ g cm^{-3}) we consider the role played by electrons scattering from degenerate neutrons and protons in the emission of neutrinos. These processes can be important if either the neutrons or the protons (but not both) are superfluid. (auth)

16265 SCANNER PHOTOMETRY OF WEAK TiO BANDS NEAR 1 MICRON IN COOL M STARS. Lockwood, G. W. (Kitt Peak National Observatory, Tucson, Arizona). Astrophys. J. 180: No. 3, 845-855 (15 Mar 1973).

Continuous scans in the region 9660–10,400 Å reveal that overlapping TiO bands depress the continua of cool M stars significantly, shortward of 10,000 Å, and are present, though weaker, from 10,000 to 10,300 Å. The bands become visible at about spectral type M3 and increase in strength throughout the M sequence; thus, they are potentially useful as spectral classification criteria for late M stars. (auth)

16266 VELOCITY GRADIENTS AND MICROTURBULENCE IN CEPHEIDS. Karp, Alan H. (Astronomy Program, University of Maryland, College Park). Astrophys. J. 180: No. 3, 895-900 (15 Mar 1973).

Variations of the microturbulent velocity with phase and height in the atmosphere have been reported in classical Cepheids. It is shown that these effects can be understood in terms of variations of the velocity gradient in the atmospheres of these stars. (auth)

16267 CONTRIBUTION TO THE STUDY OF SUPERMETALLICITY IN LATE-TYPE GIANTS. Blanc-Vaziaga, Marie-José (Département d'Astrophysique Fondamentale, Observatoire de Paris-Meudon); Cayrel, Giusa; Cayrel, Roger. Astrophys. J. 180: No. 3, 871-893 (15 Mar 1973).

This research is a detailed analysis of ϕ Aur and μ Leo, two of the best examples of "super-metal-rich" (SMR) stars found by Spinrad and Taylor by a scanner technique. They have been analyzed on high-dispersion spectrograms taken at the 100-inch Mount Wilson coudé telescope (6.8 Å mm^{-1}) for ϕ Aur and at the coudé focus of the 60-inch ESO telescope in Chile (12 Å mm^{-1}) for μ Leo. The star ϵ Vir has been used as a comparison star. Particular care has been taken only to compare spectrograms taken with the same instrumentation. (auth)

16268 THE CLASSIFICATION OF INTRINSIC VARIABLES. III. CALIBRATION OF THE LUMINOSITIES OF SMALL AMPLITUDE RED VARIABLES IN THE OLD DISK POPULATION. Eggen, O. J. (Mount Stromlo and Siding Spring Observatory, Research School of Physical Sciences, The Australian National University). Astrophys. J. 180: No. 3, 857-870 (15 Mar 1973).

Nineteen small-amplitude (less than 0.5 mag in V_E) red variables in the Hyades and old disk population groups, including 14 new variables (μ Gem, HR 4333, ϵ Oct, HD 80567, HR 4184, HR 4463, ϵ Mus, HR 1003, HD 111499, HR 7625, 27 Cnc, HD 115332, HD 123598 and HR 5331) are used to calibrate the (M_{bol}, R–I) relation. This calibration is tested with (1) FG Vul in NGC 6940, on the basis of (R, I) observations of several of the G- and K-type giants in that cluster, (2) the wide binary HR 6020, which is variable, and HR 6021, and (3) the estimates of luminosity from H and K emission widths. The similarities, in the quasi-periodic nature and changes in form of light curves, between the small-amplitude red variables and the ultrashort-period Cepheids is demonstrated with a new variable of each type; HR 7023 (M4, $P \approx 50^d$) and HR 359 (A7 III, $P \approx 0^d.05$). (auth)

16269 SOME EFFECTS OF URCA REACTIONS UPON DEGENERATE CARBON BURNING. Couch, Richard G. (Center for Nuclear Studies, Univervisity of Texas at Austin); Arnett, W. David. Astrophys. J. Lett. 180: No. 3, L101-L105 (15 Mar 1973).

The ignition of ^{12}C in degenerate cores is studied using a realistic reaction network. Convection is taken into account, and Urca neutrino losses are calculated explicitly. Urca losses from ^{23}Na–^{23}Ne inhibit ^{12}C detonation during a temporary hydrostatic stage. Collapse is initiated by the increase of μ_e caused by ^{12}C burning with subsequent electron captures. A significant fraction of the initial ^{12}C remains at the time the core evolution becomes rapid. These results are insensitive to the exact rate of the $^{12}C+^{12}C$ reaction; they apply to both Population I and Population II objects. (auth)

16270 WOLF-RAYET STARS. V. THE TEMPERATURE STRATIFICATION. Kuhi, Leonard V. (Astronomy Department,

University of California, Berkeley). Astrophys. J. 180: No. 3, 783-789 (15 Mar 1973).

The behavior of C III λ5696 with changing spectral subclass is interpreted in terms of the expanding-envelope model to indicate that in the WC stars the temperature must decrease with radius over the bulk of the envelope. (auth)

16271 SCANNER OBSERVATIONS OF HOT HELIUM-CARBON STARS. Faÿ, T.; Honeycutt, R. K.; Warren, W. H. Jr. (Goethe Link Observatory, Indiana University, Bloomington, Indiana 47401). Astron. J. 78: No. 3, 246-252 (Apr 1973).

Photoelectric spectral scans at 20 Å resolution of four hot helium-carbon-rich stars have been reduced to fluxes and are presented in graphical form. Similar flux curves for several normal (hydrogen-rich) stars in the same temperature range are presented for comparison. The helium-carbon stars BD + 10° 2179 (type B) and υ Sgr (type A) were observed from 3300-7000A, while the helium-carbon star BD + 37° 442 (type O) was observed from 3300-5300Å. Many of the absorption features seen at this resolution are identified with well-known lines of H, He I, He II, and C II. In addition, we find several broad absorption features, some of which may be due to absorption edges or line blends of C II, C III, C IV, or N IV. The origin of helium-carbon-rich envelopes is discussed in terms of the Stellar Population Type assigned by Kaufman and Hunger. A reanalysis of Wallerstein's percentages of CNO and 3-α processed material in two of these stars is made using more modern abundance values. In Bd + 10° 2179, for example, we find the ratio CNO/3-α $\simeq$0.5, whereas Wallerstein concluded CNO/3-α$\simeq$0.03, using different abundances. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 16249, 16351, 16758, and 17317–17319.

16272 POLARIZATION OF SYNCHROTRON RADIATION FROM RELATIVISTIC SCHWARZSCHILD CIRCULAR GEODESICS. Breuer, R. A. (University of Maryland, College Park, Maryland 20742); Vishveshwara, C. V. Phys. Rev. D 7: No. 4, 1008-1017 (15 Feb 1973).

. The pattern of geodesic synchrotron radiation emitted by a charge in an orbit close to the circular photon orbit at 3M around a nonrotating black hole of mass M is studied. The analysis is carried out using Stokes parameters, which completely characterize the state of the wave. The linear polarization, as observed at infinity, is total in the orbital plane and not smaller than 90% at the half-width of the beam. At the poles, pure circular polarization would be observed. In the region between the orbit plane and the poles the polarization shows features not present in ordinary synchrotron radiation. In our model, parameters more sensitive to deviations from the orbital plane are the Stokes parameter s_2 and the tilt angle of the polarization ellipse. (auth)

16273 GRAVITATIONAL RADIATION FROM A MASS PROJECTED INTO A SCHWARZSCHILD BLACK HOLE. Ruffini, Remo (Joseph Henery Physical Laboratories, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 4, 972-976 (15 Feb 1973).

Gravitational radiation emitted by a particle projected with nonzero kinetic energy from infinite distance into a Schwarzschild black hole is examined. Direct comparison between a semirelativistic approach and the fully relativistic approach in the Regge-Wheeler-Zerilli formalism gives an insight into the nature of the results. Detailed spectral distribution are given. Contrary to the case in which the particle falls in with zero kinetic energy, the spectrum does not vanish any more at low frequencies and a considerably larger amount of radiation is emitted. (auth)

16274 EXTRACTION OF ENERGY AND CHARGE FROM A BLACK HOLE. Bekenstein, Jacob D. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 4, 949-953 (15 Feb 1973).

Misner has shown that in the scattering of massless wave fields by a Kerr black hole, certain modes are amplified at the expense of the rotational energy of the hole. We show here that the existence of this effect can be deduced from simple considerations based on Hawking's theorem that the area of a black hole can never decrease; no detailed examination of the wave equations is necessary. This new approach also reveals the existence of an analog of the Misner process in which a charged wave field is amplified upon being scattered by a charged black hole with consequent extraction of charge and Coulomb energy from the hole. Additional by-products of this approach are a concise demonstration of the existence of a spin-spin force between a Kerr black hole and a nearby spinning particle, examples of the transcendence of the conservation laws for baryon and lepton numbers, and an example of a quantum violation of Hawking's theorem. The origin of this violation is discussed. (auth)

16275 QUASAR SCINTILLATIONS IN A NONHOMOGENEOUS INTERSTELLAR PLASMA. Bitkevich, V. V.; Shishov, V. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 42-45(1972). (In Russian).

The possibility of observing interstellar scintillations from radiosources of other types (not pulsars) and quasars in particular may be based on information concerning the inhomogeneities of interstellar plasma as derived from an analysis of the scintillation of pulsars. Sources 10^{-4} to 10^{-6} in. in diameter may scintillate on the inhomogeneities of interstellar plasma. From known experimental data, the scintillation of some quasars of small angular dimensions may be expected in the wavelength region of 10 to 20 cm. Sources with a diameter of 10^{-7} to 10^{-8} in. may scintillate on the inhomogeneities of outer-galactic plasma. (tr-auth)

16276 PULSAR INTENSITY VARIATIONS: SCINTILLATION ON AN INHOMOGENEOUS PLASMA. Bitkevich, V. V.; Lotova, N. A. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 46-52(1972). (In Russian).

Possible explanations for the fluctuations in pulsar intensity on different time scales are explored. Long-periodic fluctuations with a period of 10^5 to 10^6 sec may be associated with scintillation on the inhomogeneities of interstellar plasma. A sub-millisecond fluctuation may be associated with the effect of scintillation in a nonhomogeneous pulsar corona. (tr-auth)

16277 OBSERVATION OF THE OCCULTATION OF THE SOURCE 3C144 OF A SOLAR SUPERCORONA WITH THE CRUCIFORM RADIOTELESCOPE DKR-1000 FIAN. Ivanov, S. N.; Ilyasov, Yu. P. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 116-120 (1972). (In Russian).

The occultation of source 3C144 by a supercorona of the Sun was observed with a fully cruciform radiotelescope including a northern branch of the north-south line with a diagram of the directional effect 10′ × 13′ at a frequency of 101 MHz. The effect of the Sun was excluded. An eclipsing curve was obtained. The dimensions of the source, its form, and eclipsing day were estimated. (tr-auth)

16278 OBSERVATION OF STRUCTURE IN THE X-RAY SPECTRUM OF PUPPIS A. Burginyon, G.; Hill, R.; Seward, F.; Tarter, B.; Toor, A. (Lawrence Livermore Laboratory). Astrophys. J. Lett. 180: No. 2, L75-L77 (1 Mar 1973).

X-ray data from two rocket flights which scanned Puppis A show prominent structure in the energy spectrum that cannot be explained by continuum models alone. The spectral observations are well fitted by combining the effects of line radiation, radiative recombination, and bremsstrahlung from the thermal source. (auth)

16279 SHORT-TERM TEMPORAL STUDIES OF THE X-RAY EMISSION FROM CASSIOPEIA A, TYCHO, AND SCORPIUS X-1. Holt, S. S.; Boldt, E. A.; Serlemitsos, P. J. (NASA/Goddard Space Flight Center, Greenbelt, Maryland); Brisken, A. F. Astrophys. J. Lett. 180: No. 2, L69-L74 (1 Mar 1973).

No evidence for stable 2-10 keV periodic emission from Cas A or Tycho in the period range 1 ms to 10 s is found. Upper limits to the pulsed fraction are presented as a function of the assumed light curve, with absolute 99 percent confidence upper limits of 0.089 and 0.195 for Cas A and Tycho, respectively. Previously reported transient 1-10 Hz oscillations from Sco X-1 are not observed. (auth)

16280 OBSERVATIONS OF SPATIAL STRUCTURE IN THE SOFT X-RAY DIFFUSE FLUX. Bunner, A. N.; Coleman, P. L.; Kraushaar, W. L.; McCammon, D.; Williamson, F. O. (Department of Physics, University of Wisconsin, Madison). Astrophys. J. 179: No. 3, 781-788 (1 Feb 1973).

Repeated observations of a diffuse source in the region $l^{II} \approx 200°$, $b^{II} \approx +10°$ illustrate the complexity of the low-energy X-ray background. The source is not well correlated with known objects or features, and cannot be explained by geometrically simple models of diffuse emission. The measurements indicate that this emission feature, and by implication a large fraction of the 1/4-keV flux observed in the galactic plane, probably originates outside the solar system. (auth)

16281 VARIATIONS OF THE RADIO SOURCE OJ 287 AT OPTICAL WAVELENGTH. Visvanathan, N. (Harvard College Observatory, Cambridge, Massachusetts); Elliot, J. L. Astrophys. J. 179: No. 3, 721-730 (1 Feb 1973).

Accurate photoelectric observations of the radio source OJ 287 and a standard star during 1972 March indicate the possible presence of a periodic component with a period of 39.2 min and an amplitude of 0.0065 mag. Examination of the light from OJ 287 for discrete frequency components and broad-band noise over a range of frequencies from 1.0×10^{-3} to 1.2×10^{1} Hz does not reveal any peak in the power spectrum to our levels of sensitivity. The light curve obtained from the available photographic plates, dating from 1894 to the present, exhibits four bursts with timescales of several months. A slowly varying component rising and falling over a period of 2 years can be seen in the 1971 outburst. Similarities between OJ 287 and BL Lac are discussed. (auth)

16282 SOFT X-RAYS FROM THE CYGNUS LOOP. Stevens, J. C. Pasadena, CA; California Inst. of Tech. (1973). 226p. University Microfilms Order No. 73-14,318.

Thesis (Ph. D.).

A detailed soft x-ray survey of the Cygnus Loop, obtained from a rocket-borne experiment, provides evidence that the x-ray emission from this supernova remnant is produced by the interaction of a shock wave and the interstellar medium. A spatial map, having 0.5° by 0.5° resolution, of the structure of the Cygnus Loop in 0.2- to 1.5-keV x rays is presented. The map shows regions of x-ray emission which correlate well with features at radio and optical wavelengths. It also shows regions for which the antithesis holds. A detailed spectral examination of the total emission from the Loop by a proportional counter equipped with a two-element filter system, shows evidence for line emission between 530 and 690 eV. The overall spectrum is found to be well represented by a thermal bremsstrahlung spectrum with line emission. The intensity of x-ray emission between 0.2 and 1.5 keV from the Cygnus Loop is found to be $1.2 \pm 0.3 \times 10^{-8}$ ergs/cm^2-sec at the Earth. Assuming a distance of 770 pc to the Loop and a columnar density of interstellar hydrogen of $.48 \pm .02 \times 10^{21}$ atoms/cm^2 the total energy radiated in 0.2- to 1.5-keV x rays by the Loop is found to be 2.1×10^{36} ergs/sec. An inhomogeneous anisotropic shock wave model of the Cygnus Loop is found to be required by the data. Such a model is developed and is shown to explain the spatial and spectral appearances of the Cygnus Loop in soft x rays. The model requires a shock front expansion velocity only as large as that implied by the optical radial velocity measurements. (Diss. Abstr. Int., B)

16283 EMISSION MECHANISM IN PULSARS. Smith, F. G. (Univ. of Manchester, Eng.). Nature (London); 243: No. 5404, 207-210(25 May 1973).

In a new model of the emission from pulsars based on the relativistic beaming effect, the source of the radiation is the circular motion of high-energy electrons round magnetic field lines. The radio emission at the gyrofrequency is from coherent bunches of electrons, and the optical and x-ray emission is the incoherent synchrotron radiation from the same electrons. (auth)

16284 WIDE INTEGRATED PULSE PROFILES OF PULSARS. Backer, D. C.; Boriakoff, V.; Manchester, R. N. (National Records Management Council, Inc., New York). Nature (London) Phys. Sci.; 243: No. 127, 77-78(4 Jun 1973).

It is stated that in most pulsars the width of the integrated pulse profiles at half the peak intensity is about 3% of the period, and significant emission is not observed outside the immediate vicinity of this pulse. Notable exceptions are pulsars with two narrow pulses in the integrated profile separated by about half a pulse period, and attention is drawn to several pulsars which emit over large fractions of their pulse period; this represents an aspect of pulsar radiation that needs to be considered in future pulsar models. Two types of extended emission have been observed and are discussed. In the first the emission is weak and forms a bridge between the main pulse and a second pulse; emission of this type has been observed for the Crab pulsar. PSR 0950+08 also shows a weak bridge between the interpulse and the main pulse, as also does PSR 0823+26. In the second type of extended emission the half intensity pulse width is much greater than the typical 3%; examples are PSR 1541+09 and PSR 2111+46. The objects discussed are extreme cases of a continuous distribution of pulse widths and weak pulse separations. Other pulsars discussed include PSR 1857+25, 1944+17, 2021+51, 0329+54, and 0531+21. The observations show that, in some pulsars, emission is present over a large fraction of the pulse period, a feature also observed in optical and x-ray pulsars. For pulsar models in which the emission region is near the velocity of light cylinder of a rotating neutron star this implies that emission regions must be distributed around a large part of the circumference. (UK)

16285 COMPACT RADIO SOURCE ASSOCIATED WITH THE OH SOURCE ON-1 (OH69.5-1.0). Winnberg, A.; Habing, H. J.; Goss, W. M. (Max-Planck-Institut fuer Radioastronomie, Bonn). Nature (London) Phys. Sci.; 243: No. 127, 78-81(4 Jun 1973).

It is stated that most class I OH sources found in large scale OH surveys are close to large diffuse H II regions and are often associated with small compact continuum sources. The discovery of an isolated high density H II region associated with a class I OH source is here reported; there was no detectable low density H II region surrounding the compact source. This source may well be the first stage in the evolutionary process of the H II region. A search is being carried out for compact radio sources close to class I OH sources using the Westerbork Synthesis Radio Telescope and the 100 m Radio Telescope at Effelsberg. The first object of investigation was ON-1 (OH 69.5-1.0), and a point source of $170 \pm 20 \times 10^{-3}$ fu was detected, probably having a thermal spectrum. Some properties of the H II region G 69.5-1.0 were calculated using the formula for a homogeneous spherical model. Implications arising from a preliminary analysis of the data for the source are (1) the location of class ± OH sources is not limited to the neighborhood of large evolved H II regions; surveys for main line OH emission should therefore be carried out by mapping regions of the galactic belt irrespective of the presence of continuum sources; (2) because of the small amount of ionized mass and the small size, G 69.5-1.0 is undoubtedly a young H II region; (3) if the compact H II regions are the ionized remnants around newly formed stars, then it would be expected to find many of them in regions of the galaxy where formation of massive stars has just started; in this case no advanced H II regions have yet developed. (UK)

16286 BEGINNINGS OF RADIO ASTRONOMY IN AUSTRALIA. Wild, J. P. (CSIRO, Kensington, Australia). Rec. Aust. Acad. Sci.; 2: No. 3, 52-61(Nov 1972).

Post-war development of work at the CSIR Radiophysics Laboratory is described. A list of Australian publications on radio astronomy from 1946 to 1952 is appended. (AT)

16287 REDSHIFT OF OQ172. Wampler, E. J.; Robinson, L. B.; Baldwin, J. A.; Burbidge, E. M. (Univ. of California, Santa Cruz). Nature (London); 243: No. 5406, 336-337(8 Jun 1973).

The discovery of a second QSO with a redshift >3 is reported. Spectra taken with the 120 in. telescope at Lick Observatory gave Z = 3.53 for OQ 172. It is stated to be common for large redshift QSOs to have absorption features, and OQ 172 seems to have one of the richest absorption spectra known. The possibility arises that the absorption line systems have a much lower redshift than the emission line system. A program is under way to obtain higher resolution spectra of this object, that should help to resolve some of the questions. Other similar objects presumably exist. (UK)

16288 INTERSTELLAR METHYLACETYLENE AND ISOCYANIC ACID. Snyder, L. E. (Univ. of Virginia, Charlottesville); Buhl, D. Nature (London) Phys. Sci.; 243: No. 125, 45-46 (21 May 1973).

The authors had previously reported the radio detection of an emission line from the $J_K = 5_0 \rightarrow 4_0$ transition of interstellar methylacetylene (propyne) at 85,457.29 MHz in the direction of the galactic center source Sgr B2. This was of interest since only one other seven-atom molecule, acetaldehyde, had been found in the interstellar medium, and these two species now represent the known limit of structural complexity allowed by interstellar molecular chemistry. Later, new and better methylacetylene data were obtained with enough spectral quality to allow the observation of more than one component of the J = 5-4 transition; in addition a new transition of interstellar isocyanic acid was detected, as well as a weak unidentified line. Observations were made with the 36 ft radiotelescope of NRAO, and the results of the accumulated observations are discussed. Methylacetylene is stated to be the only known interstellar molecule serving as a possible indicator of both methane and acetylene, both of which may be important constituents of interstellar dust grains; furthermore this compound may photodissociate to form C_3 and H_2, and hence is a potential source for other interstellar molecules. Further surveys with more sensitive receivers give promise of giving more information about the chemistry and temperature of interstellar regions outside the galactic center. (UK)

16289 X-RAYS FROM THE UNIVERSE. Stuhlinger, E. Fortschr. Geb. Roentgenstr. Nuklearmed.; 118: No. 4, 365-377 (1973). (In German).

From Deutscher Roentgenkongress; Stuttgart, Germany (11 May 1972).

A short survey is given for a general audience on the development and the results of x-ray astronomy. The following topics are covered: mechanisms for the production of cosmic x rays, the different types of observed cosmic x-ray sources (galaxies, quasars, Seyfert galaxies, supernova remnants, neutron stars), observational methods for x rays by means of satellites and possible radiation risks of astronauts from x radiation. (GE)

16290 RADIO STARS AR LACERTAE AND CYGNUS X-2. Hjellming, R. M.; Blankenship, L. C. (National Radio Astronomy Observatory, Green Bank, WV). Nature (London) Phys. Sci.; 243: No. 127, 81-82(4 Jun 1973).

Observations are reported of radio emission from AR Lacertae, which is an Algol type eclipsing and spectroscopic binary with a period of 1.98 d, and from the peculiar blue star suggested as the optical counterpart of the x-ray source Cygnus X-2. The observations were made during February and March 1973 using the NRAO interferometer operating at 2695 and 8085 MHz. Observed radio

flux densities are shown tabulated. The AR Lac data indicate that its behavior is similar to that of β Persei. The radio source spends much of its time in a state where it has a flat radio spectrum and as in the case of β Persei there are indications of mass loss and/or mass exchange in the system with occurrence of complex gas streaming. It is tempting to believe that there is a relationship between such gas streaming phenomena and the production of variable radio emission. The detection of radio emission from the peculiar blue star identified with Cyg X-2 prompted further observing of the source and reexamination of older data using improved methods of analysis, and there was no doubt about the detection of radio emission. All of the data indicate that the radio source at 8085 MHz is variable by at least 50%. (UK)

16291 ORIGIN OF BROAD EMISSION LINES FROM QUASI-STELLAR OBJECTS. Ptak, R.; Stoner, R. (Bowling Green State Univ., Ohio). Nature (London); 243: No. 5405, 280(1 Jun 1973).

It is stated that the optical spectra of QSOs show very broad high excitation emission lines. The broadest of these in the visible region for typical redshifts are the resonance lines Lyα λ1216, CIV λ1550, and MgII λ2798. Previous suggestions for the breadth of these lines include electron scattering and Doppler shifts due to turbulence or other mass motions in gas clouds. The authors recently proposed a radially streaming proton model that gives an excellent fit to profiles of the broad Hα emission lines from some Seyfert galaxy nuclei, and it is suggested here that a similar idea might also explain the observed width of QSO emission lines. In the model suprathermal protons slow down as they stream radially through H_2 that is at rest with respect to their source. Hydrogen emission from these protons occurs when they have slowed to speeds less than about 5000 km/s, and are able to carry an electron for an appreciable period. The H emission profiles are predicted to have overall Doppler widths of about 10,000 km/s at near zero intensity. Profiles for Lyα are shown, computed by such a model, and preliminary calculation of profiles have been made for CIV λ1550. If the computed profiles agree with QSO emission profiles as well as they do with the H emission profiles of Seyfert galaxies, then strong evidence will be provided that at least the fine structure constant must have the same value in a QSO as it does in the solar system. (UK)

16292 HD 153919 AND THE X-RAY SOURCE 2U 1700-37. Walker, E. N. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 15P-20P(1973).

HD 153919 is the prime optical candidate for the x-ray source 2U 1700-37. Radcliffe spectra show the star to be an 05.5f star with a strong line of C III. The radical velocities indicate that the star has an expanding atmosphere. The star is both a radial velocity and spectrum variable. Attention is drawn to some very broad, variable emission features underlying the main stellar spectrum. (auth)

16293 SPECTROSCOPIC AND PHOTOMETRIC OBSERVATIONS OF THE QUASAR 4C 31.63. Tritton, K. P.; Henbest, S. N.; Penston, M. V. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 31P-34P(1973).

Spectra have been obtained of Olsen's (Astr. J.; 75: 764(1970)) suggested identifications of 4C 31.63 and 4C 24.6. These show that the former is a quasar but the latter is a foreground star. Photoelectric UBVRI magnitudes place the quasar among the 10 brightest known. (auth)

16294 QSO'S NEAR BRIGHT GALAXIES. Browne, I. W. A.; McEwan, N. J. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 21P-24P(1973).

The number of apparent associations between bright galaxies and QSO's from the Parkes 2700 MHz survey is investigated in the light of improved optical identifications. (auth)

16295 EARTH AS A NONRESONANT DETECTOR OF GRAVITATIONAL RADIATION FROM A PULSAR IN THE CRAB NEBULA. Stoyanov, V. I. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 16: No. 5, 19-22(1973). (In Russian).

The displacement of the Earth's surface caused by the incident gravitational radiation from the Crab Nebula pulsar was evaluated on the basis of the energy balance of such a pulsar. The Earth was regarded as a quadrupolar detector of gravitational waves, and the total power of the pulsar radiation was assumed to be 10^{38} erg/sec, the distance 4×10^{21} cm, and the frequency of the emitted wave 400 sec^{-1}. The lifetime of the pulsar was calculated to be 6.92×10^{11} sec. (KSW)

16296 EFFECTS OF SCATTERING OF THE GRAVITATIONAL AND ELECTROMAGNETIC WAVE PACKETS ON THE GRAVITATIONAL FIELD OF A "BLACK HOLE". Sibgatullin, N. R. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 209: No. 4, 815-818(1973). (In Russian).

The equations of an electromagnetic field in a Maxwellian vacuum and an Einstein gravitational field are discussed in connection with a solution to Kosh's problem in the presence of a configuration of bicharacteristics of an unstable limiting cycle. It is essential to allow for the effects of scattering for wave packets, the trajectories of which in the beginning are close to the bicharacteristic coiled in the limiting cycle. An asymptotic method was derived which allows the calculation of the coefficients of reflection and penetration of a wave in a Schwarzschild field. (KSW)

16297 ROTATING MAGNETOSPHERES: AN EXACT 3-D SOLUTION. Michel, F. Curtis (Space Science and Physics Departments, Rice University, Houston). Astrophys. J. Lett. 180: No. 3, L133-L137 (15 Mar 1973).

We derive the basic equations governing the magnetic-field-line configuration and plasma flow about a rotating object having an axisymmetric field in the limit that the plasma inertia can be neglected (strong magnetic fields). We show that the field-line equations can be written in a very simple compact form as a second order partial differential equation which is, however, nonlinear. We also show that, in the monopole case, this differential equation has an exact solution: the field lines spiral out on conical surfaces, making an angle ξ with the radial direction where $\tan \xi = \omega\rho/C$, with ω the rotation rate and ρ the distance from the axis of rotation. Exact expressions are given for all other relevant physical quantities. (auth)

16298 RAPIDLY ROTATING DEGENERATE DWARFS AS X-RAY SOURCES IN BINARIES. Brecher, K.; Morrison, P. (Department of Physics and Center for Space Research, Massachusetts Institute of Technology). Astrophys. J. Lett. 180: No. 3, L107-L112 (15 Mar 1973).

We suggest that the recently discovered pulsing binary X-ray sources Her X-1 and Cen X-3, as well as binary X-ray companions in general, may be rapidly rotating degenerate dwarfs. The model accounts in a natural way for their presence in binary systems, observed luminosity, pulse period, and rate of spin up. No black holes are required even in possibly massive star systems such as Cyg X-1. (auth)

16299 BLACK HOLES AND ENTROPY. Bekenstein, Jacob D. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 8, 2333-2346 (15 Apr 1973).

There are a number of similarities between black-hole physics and thermodynamics. Most striking is the similarity in the behaviors of black-hole area and of entropy: both quantities tend to increase irreversibly. In this paper we make this similarity the basis of a thermodynamic approach to black-hole physics. After a brief review of the elements of the theory of information, we discuss black-hole physics from the point of view of information theory. We show that it is natural to introduce the concept of black-hole entropy as the measure of information about a black-hole interior which is inaccessible to an exterior observer. Considerations of simplicity and consistency, and dimensional arguments indicate that the black-hole entropy is equal to the ratio of the black-hole area to the square of the Planck length times a dimensionless constant of order unity. A different approach making use of the specific properties of Kerr black holes and of concepts from information theory leads to the same conclusion, and suggests a definite value for the constant. The physical content of the concept of black-hole entropy derives from the following generalized version of the second law: When common entropy goes down a black hole, the common entropy in the black-hole exterior plus the black-hole entropy never decreases. The validity of this version of the second law is supported by an argument from information theory as well as by several examples. (auth)

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Refer also to abstracts 16400 and 17252.

16300 SPACE PHYSICS AND SPACE ASTRONOMY. Papagiannis, M. D. New York; Gordon and Breach, Science Publishers, Inc. (1972). 303p. $15.95.

Topics covered include planetary atmospheres, the ionosphere, magnetosphere, the active Sun, interplanetary space, solar-terrestrial relations, solar and planetary space astronomy, and galactic space astronomy. (WDM)

16301 SEARCH FOR CONTINUOUS ULTRAVIOLET OPACITY SOURCES IN THE SUN'S PHOTOSPHERE. Landi Degl' Innocenti, E.; Noci, G. (Astrophysical Observatory, Florence). Solar Phys.; 29: No. 2, 287-297(Apr 1973).

Experimental results on limb darkening and specific intensities imply more ultraviolet continuous opacity than that predicted by theoretical calculations. Some atomic and molecular processes not yet studied from this standpoint were investigated as to their importance on the continuous absorption coefficient. The negative results obtained suggest some arguments about the importance of iron as photo-absorber. (auth)

16302 NEAR ULTRAVIOLET FLUX OF THE HARVARD–SMITHSONIAN REFERENCE ATMOSPHERE. Bell, R. A. (Univ. of Maryland, College Park). Solar Phys.; 29: No. 2, 299-300 (Apr 1973).

The emergent specific intensity calculations were carried out for the Harvard–Smithsonian Reference Atmosphere using three different sets of opacities. (WDM)

16303 EXTREME ULTRAVIOLET EMISSION FROM CHROMOSPHERIC INHOMOGENEITIES. An Analysis of the Extreme Ultraviolet Flash Spectrum of the Sun. Brueckner, G. E.; Nicolas, K. R. (Naval Research Lab., Washington, DC). Solar Phys.; 29: No. 2, 301-315(Apr 1973).

An Aerobee 170 rocket carried five slitless extreme ultraviolet spectroheliographs into the March 7, 1970, solar eclipse. Salt water damage left latent images on 16 exposures of the euv camera covering the wavelength range from 1390 Å to 1945 Å. The salt water damage made the absolute calibration of the spectroheliograms uncertain. Therefore, the analysis is based on a comparison of the extent of flash spectrum crescents from emission lines formed in the chromosphere–corona transition zone with two simple but fundamentally different models describing this region. The observations can be satisfactorily described by an inhomogeneous model where cool spicules are surrounded by a transition zone which has the same temperature and density structure as the chromospheric coronal transition zone customarily used in spherically symmetric models of the quiet Sun. (auth)

16304 HIGH-RESOLUTION PHOTOGRAPHY OF THE SOLAR CHROMOSPHERE. X. Physical Parameters of Hα Mottles. Bray, R. J. (Commonwealth Scientific Industrial Research Organization, Sydney). Solar Phys.; 29: No. 2, 317-325(Apr 1973).

High-resolution filtergrams of the quiet chromosphere, taken at seven wavelengths in Hα with the aid of a computer-controlled $\frac{1}{8}$ Å filter, were used to derive the contrast of ten bright and dark mottles as functions of wavelength. The contrast profiles of bright and dark mottles were strikingly different. They disagree with Athay's (1970) "velocity" model but, with an appropriate choice of parameters, can be brought into good agreement with Beckers' (1964) "cloud" model. Comparison between observation and theory yields values for the source function S, optical thickness t_0, line broadening parameter $\Delta\lambda_0$, and line-of-sight velocity V for both bright and dark mottles. The values of S and t_0 obtained for dark mottles are consistent with Beckers' (1968) spicule model. (auth)

16305 HIGH-RESOLUTION PHOTOGRAPHY OF THE SOLAR CHROMOSPHERE. XI. Hα Contrast Profiles of Mottles Near the Limb. Loughheaed, R. E. (Commonwealth Scientific and Industrial Research Organization, Sydney). Solar Phys.; 29: No. 2, 327-332(Apr 1973).

Curves showing the contrast of individual bright and dark mottles near the limb at various wavelengths in the Hα line were plotted from observations made through a $\frac{1}{8}$ Å filter. The results cannot be explained in terms of the "cloud" model of mottles proposed by Beckers (1964) and employed with some success by Grossmann–Doerth and von Uexkuell (1971) and Bray (1973) to interpret the profiles of bright and dark mottles near the center of the disk. (auth)

16306 FORMATION OF Mg I 4571 A IN THE SOLAR ATMOSPHERE. II. The Effect of One-Dimensional Macroscopic Velocity Fields. Altrock, R. C.; Cannon, C. J. (Univ. of Sydney). Solar Phys.; 29: No. 2, 275-286(Apr 1973).

An analysis of the 4571 Å line of neutral magnesium is presented in which one-dimensional macroscopic velocity fields are included. It is shown that gradients over restricted heights in the vertical and horizontal components of the velocity field of order $-0.005\ s^{-1}$ and $-0.004\ s^{-1}$ (such that velocity towards the observer decreases as height increases), respectively, result in asymmetries in the computed line profile similar to those observed. The heights in the solar atmosphere at which these velocity gradients exist are shown to be very critical in reproducing the observations. It was found that the best results were obtained when the gradients existed in the height range from ~200 km to ~300 km below the temperature minimum. The results indicate that for the Mg I 4571 Å line model calculations that do not include one-dimensional flow velocities may safely be compared with frequency-averaged observations. (auth)

16307 AUTOMODELS OF SOLUTIONS TO PLASMA EQUATIONS. Konyukov, M. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 183-187(1972). (In Russian).

The conditions are investigated under which a system of plasma equations allows solutions of an automodel type. Such conditions were established for motions with an essential role of collisions, and solutions were obtained in closed form for the case of the dispersion of a plasma in a vacuum. In a collision-free form, an iteration procedure is indicated for obtaining equations of an automodel type. (tr-auth)

16308 ESTIMATE OF THE SIZE OF A MAGNETIC FIELD IN THE SOLAR CORONA FROM MEASUREMENTS OF THE LINEAR POLARIZATION OF SOLAR RADIO BURSTS. Alekseev, Yu. I. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 61-67(1972). (In Russian).

Measurements were taken of the linear polarization in solar radio bursts at two frequencies in the neighborhood of 207 MHz. Values of the longitudinal component of the magnetic field in the solar corona, obtained from measurements of the Faraday effect, were of the order of 10^{-3} Oersted. The effect of polarization on these measurements is discussed. (tr-auth)

16309 NATURE OF THE INHOMOGENEOUS STRUCTURE OF A NEAR SOLAR PLASMA. Baikov, I. S.; Lotova, N. A. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 53-60(1972). (In Russian).

Various types of inhomogeneities which are possible under the conditions of a near-solar plasma are analyzed. Drift "slipping" inhomogeneity is examined, the inhomogeneity evoked by an anisotropic distribution of temperature. The small-scale structure observable by the techniques of radio astronomy may be associated with different types of inhomogeneity in the various regions of a near-solar plasma. (tr-auth)

16310 NATURE OF THE SOLAR WIND. Konyukov, M. V. Tr. Fiz. Inst., Akad. Nauk SSSR; 62: 20-32(1972). (In Russian).

Observations on the solar corona and interplanetary plasma are discussed relative to the formation of a current with velocities of the order of 300 to 400 km/sec near the Earth's orbit. The powerful current arises from a heat source which provides heating of the solar corona, and the emergence of directed velocities is associated with the transformation of the energy because of the electron conductivity in the hydrodynamic approximation of the ions. The possible role of magnetic fields which are "frozen in" the solar-wind plasma is discussed. (tr-auth)

16311 X-RAYS SPECTROHELIOGRAMS IN LINES OF Mg XI AND Mg XII. Bonnelle, C. (Univ., Paris); Senemaud, C.; Senemaud, G.; Chambe, G.; Guionnet, M.; Henoux, J. C.; Michard, R. Solar Phys.; 29: No. 2, 341-355(Apr 1973).

Spectroheliograms in the Lα Mg XII line and in the Mg XI resonance (R) $1s^2\ {}^1S_0 - 1s2p\ {}^1P_1$ line, intercombination (I) $1s^2\ {}^1S_0 - 1s2p\ {}^3P_{1,2}$ line, and the forbidden (F) $1s^2\ {}^1S_0 - 1s2s\ {}^3S_1$ line, were obtained. Two Bragg crystal spectrometers were used mounted with mechanical collimators to obtain a spatial resolution of $1' \times 3'$. The apparatus was launched on a sounding rocket on July 2, 1971. A particularly thorough study was made of the brightest active region (MC 11402). Variations in the F to I Mg XI line intensity ratio from one point to another in the active region did not reveal the presence of high electron densities. The observed intensities of the Mg XI R line, Mg XII Lα line, and Mg X $1s^22s\ {}^2S_{\frac{1}{2}} - 1s2p\ {}^1P\ 2s \times {}^2P_{\frac{1}{2},\frac{3}{2}}$ S line are not well explained by an isothermal model. Good agreement between computed and observed intensities is obtained using the nonisothermal model proposed here. (auth)

16312 CORONAL DENSITY AND TEMPERATURE GRADIENTS. Athay, R. G. (High Altitude Observatory, Boulder, CO). Solar Phys.; 29: No. 2, 357-364(Apr 1973).

Mean density models of the solar corona show evidence for two distinctive density regimes characterized by different density gradients. High density gradients are identified with regions of predominantly open magnetic lines of force and low density gradients are identified with regions of predominantly closed magnetic lines of force. Spectroscopic data yielding equivalent widths of forbidden lines of Fe X and Fe XIV strongly suggest that the coronal temperature for $r > 2.5\ R_\odot$ decreases considerably less rapidly in equatorial regions than $r^{-\frac{2}{3}}$, which is the decrease predicted by conduction models with open field lines. (auth)

16313 VIDEOMAGNETOGRAPH STUDIES OF SOLAR MAGNETIC FIELDS. I. Magnetic Field Diffusion in Weak Plage Regions. Smithson, R. C. (California Inst. of Tech., Pasadena). Solar Phys.; 29: No. 2, 365-382(Apr 1973).

Observations of magnetic field diffusion in weak plage regions were made using the analog videomagnetograph at the California Institute of Technology. Points of magnetic flux, usually described as "vertex points" of the magnetic network, were found to have a mean lifetime of three to four days, and to disperse primarily by means of two mechanisms: a random walk with a step time short compared to 24 h, and a sudden transport of magnetic flux over distances of 5000 to 20,000 km during a time span of one to three hours. The second mechanism is probably the predominant one. Similar observations were made using K_3 spectroheliograms. (auth)

16314 COMMENTS ON THE ZIRIN–FRAZIER CONTROVERSY. Cheng, C. C. (Naval Research Lab., Washington, DC); Phillips, K. J. H.; Wilson, A. M. Solar Phys.; 29: No. 2, 383-384(Apr 1973).

It is concluded that any assumed relation between the Hα fine structure and the chromospheric magnetic field can only be verified by actually measuring the magnetic field in the chromosphere. (WDM)

16315 SHORT-PERIODIC OSCILLATIONS OF THE MAGNETIC FIELD OF THE SUN AS A STAR. Ioshpa, B. A.; Obridko, V. N.; Shelting, B. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Solar Phys.; 29: No. 2, 385-392(Apr 1973).

Correlation analysis applied to recordings of the magnetic field and velocity of the Sun as a star reveals oscillations close to 300 s. The power spectrum of these oscillations is discussed. (auth)

16316 SEARCH FOR CIRCULAR POLARIZED EMISSION FROM SOLAR HEMISPHERES AT MICROWAVES. Kaufmann, P.; Scalise, E. Jr.; Schaal, R. E.; Lepine, J. R. D.; Basu, D.; Ibanez, A. L. (Univ. Mackenzie, Sao Paulo, Brazil). Solar Phys.; 29: No. 2, 393-397(Apr 1973).

Solar mappings with moderate angular resolution at 7 GHz seem to support the hemispherical dependence of the sense of circular polarization being right-handed for the southern hemisphere, and left-handed for the northern hemisphere. One explanation of the effect can be found by taking into account the "missing" fields from active centers, emerging from one hemisphere and immersing into the other. (auth)

16317 POSITIONS OF FILAMENT FEET IN RELATION TO THE SUPERGRANULAR CALCIUM NETWORK. Plocieniak, S.; Rompolt, B. (Univ., Wroclaw). Solar Phys.; 29: No. 2, 399-401(Apr 1973).

On the basis of Hα and K Ca II spectroheliograms the positions of filament feet with regard to the supergranular network were established. It was found that 65% of the filament feet is located at the junctions of three or four supergranular cells, 25% at the junctions of two cells, and 10% in the area of the cells. (auth)

16318 OBSERVATIONS OF AN ACTIVE LIMB PROMINENCE IN THE Hβ LINE. Burns, J. (Univ. of Hawaii, Honolulu). Solar Phys.; 29: No. 2, 403-408(Apr 1973).

Measurements of the Hβ line intensity in a large active prominence indicate that α, the fraction of length in the line of sight which contains emitting material, is less than or equal to 0.1. (auth)

16319 SOLAR ACTIVE REGION AT 9 AND 3.5 MM WAVELENGTHS UNDER DISTURBED CONDITIONS. Kundu, M. R.; Liu, S. Y. (Univ. of Maryland, College Park). Solar Phys.; 29: No. 2, 409-415(Apr 1973).

Some properties of solar active regions at 9 and 3.5 mm wavelengths under disturbed conditions are discussed. New regions develop or weak regions intensify at millimeter wavelengths as a result of flares at distant sites. The spectra of the peak flux density of moderately strong bursts observed at 9 mm show a sharp drop toward the shorter millimeter wavelengths. The weak bursts at 3.5 mm manifest mainly as heating phenomena. (auth)

16320 COMMENT ON THE FLARE ACTIVITY IN AUGUST 1972. Fritzova-Svestkova, L.; Svestka, Z. Solar Phys.; 29: No. 2, 417-419(Apr 1973).

It is shown that the occurrence of a series of major flares in August 1972 was nothing unusual when compared with the preceding solar cycles. The surprise was due to the long delay of 3.7 yr after solar maximum. (WDM)

16321 IONIZATION OF HYDROGEN IN OPTICAL FLARES. Brown, J. C. (Univ. of Glasgow). Solar Phys.; 29: No. 2, 421-427(Apr 1973).

Non-steady state and non-LTE effects on the ionization equilibrium of hydrogen in optical flares are considered in terms of a two-level hydrogen atom. It is shown that, just as in the quiet low chromosphere, the ionization equation is controlled by spontaneous recombination to the second level and by photoionization from this level by photospheric radiation, and is independent of the nature of the flare energy input mechanism. Adjustment of the ionization then occurs on the recombination time scale which is short compared to the flare heating time scale. Consequently the ionization is given by a simple LTE-modification of Saha's equation at the instantaneous electron temperature obtained from the energy equation. These conclusions are contrasted with those of previous authors who, by using one-level atoms only, have omitted the optically thin Balmer continuum which dominates the optically thick Lyman transitions. (auth)

16322 CONTINUOUS ENERGY INJECTION AT NUMEROUS BRIGHT POINTS DURING SOFT X-RAY FLARE ENHANCEMENT. Glencross, W. M. (Royal Inst. of Tech., Stockholm). Solar Phys.; 29: No. 2, 429-439(Apr 1973).

The common assumption that a single volume of plasma produces x-ray emission during solar flares is difficult to reconcile with the very complex structure observed in Hα spectroheliograms. Nevertheless such a model has been considered reasonably adequate because the rapid rise and slow decay of emission has approximately the form expected when a plasma volume, isolated thermally from its surroundings, is heated quickly in the early stages of the event. Data presented show that a number of secondary peaks in intensity are usually observed throughout the soft x-ray emission. These can be explained by a model in which the x-ray emission comes from many relatively short-lived volumes of hot plasma. It appears that the lifetime of each such region is about five minutes, while the Hα spectroheliograms suggest that they are spaced throughout the extended region of activity. The relatively long period of flare activity arises because new volumes of plasma appear as others decay. Since each of these regions has to be energized during its development it is concluded that energy is released throughout the period of the x-ray flare. (auth)

16323 SOLAR X-RAY SPECTRA OBSERVED FROM THE INTERCOSMOS-4 SATELLITE AND THE VERTICAL-2 ROCKET. Grineva, Yu. I.; Karev, V. I.; Korneev, V. V.; Krutov, V. V.; Mandelstam, S. L.; Vainstein, L. A.; Vasilyev, B. N.; Zhitnik, I. A. (Lebedev Inst. of Physics, Moscow). Solar Phys.; 29: No. 2, 441-446(Apr 1973).

Results are given of the detailed analysis of fourteen Fe XXV – XXIII lines (λ = 1.850 to 1.870 Å) in the spectra of a solar flare on Nov. 16, 1970. The spectra were obtained with a resolution of about 4×10^{-4} Å, which revealed lines not previously observed and allowed the measurement of line profiles. The measured values of the wavelengths and emission fluxes are presented and compared with theoretical calculations. The analysis of the contour of the Fe XXV line (λ = 1.850 Å) leads to the conclusion that there is unidirectional macroscopic gas motion in the flare region with the velocity (projection on the line of sight) $\approx \pm 90$ km s^{-1}. Measurements of the 8.42 Å Mg XII and 9.16 Å Mg XI lines in the absence of solar flares indicate prolonged existence of active regions on the solar disk with $T_e = 4$ to 6×10^6 K and emission measure ME $\approx 10^{48}$ cm^{-3}. The profile of the Mg XII line indicates a macroscopic ion motion with a velocity up to 100 km s^{-1}. (auth)

16324 MAY 19-20, 1969, AN EXAMPLE OF TYPE III EMISSION DURING THE IMPULSIVE PHASE OF FLARES. Vorpahl, J. (Sacramento City Coll., CA). Solar Phys.; 29: No. 2, 447-460 (Apr 1973).

Two multiple impulsive events in May 1969 were examined and their impulsive Hα, hard x-ray, and microwave components were compared to the observed type III emission. No good correlation was observed between meter intensity and the degree of simultaneous Hα outflow although almost every type III burst had some associated Hα activity. Correspondingly, an inverse relationship existed between x-ray and type III emission, i.e., a strong meter burst accompanied weak hard X radiation. This, along with the fact that sufficient energetic electrons were normally present to produce the x rays, implies that the trajectory, rather than electron spectrum or supply, determines whether type III noise is observed during an impulsive event. (auth)

16325 INTERFEROMETER OBSERVATION OF PULSATING SOURCES ASSOCIATED WITH A TYPE IV SOLAR RADIO BURST. Kai, K. (Tokyo Univ., Mitaka, Japan); Takayanji, A. Solar Phys.; 29: No. 2, 461-475(Apr 1973).

An extremely complex outburst, part of which showed unusually rapid intensity fluctuations of a few second interval, was observed on November 5, 1970 with the 160 MHz interferometer of the Nobeyama Solar Radio Station. The pulsating source, which was stable in position and strongly circularly polarized (~60%), had an extension as large as 17′ (7.5×10^5 km) in the east–west direction. The structure of the source remained unchanged while the source darkened and brightened repeatedly. The change of the source brightness occurred in a time shorter than a second. Two alternative mechanisms responsible for the pulsating phenomenon are suggested; (1) gyroresonance absorption of continuum radiation by a fast particle beam injected in a quasi-periodic manner into a large region of weak magnetic field, or (2) magnetohydrodynamic oscillation of the continuum source itself, which is intrinsically much smaller than observed. It is observed as a large source as a consequence of scattering of the emitted radiation in a region situated above the source. (auth)

16326 COMPARISON OF THEORETICAL AND EXPERIMENTAL ESTIMATES OF THE SOLAR PROTON DIFFUSION COEFFICIENT DURING THREE FLARE EVENTS. Webb, S.; Balohgh, A.; Quenby, J. J.; Sear, J. F. (Imperial Coll. of Science and Tech., London). Solar Phys.; 29: No. 2, 477-503(Apr 1973).

The propagation time for solar protons observed during the events of January 24, February 25, and March 17, 1969 are compared with those estimated from numerical solutions of the Fokker–Planck transport equation, using values of the diffusion co-

efficient of the form $K_r = K_0 r^b$ where r is radial distance from the Sun, K_0 is obtained from the plasma-field parameters near the Earth, and b varies from −3 to +1. K_0 is derived either by assuming that all the magnetic fluctuation power is in small amplitude transverse waves or alternatively in discontinuous changes in |B| along the flux tube of propagation. In the first case it is found that the K_0 values calculated require either $b \approx -3$, implying a very rapid wave growth with r, or the Fokker–Planck equation reduces to the situation of purely convective transport which is at variance with the experimental observations. More reasonable results are found in the second case although even here K_0 is probably underestimated. Alternative ways of deducing K_0 empirically from particle anisotropy measurements are put forward and these seem to favor the discontinuity model. (auth)

16327 CORONAL HOLE AND ITS IDENTIFICATION AS THE SOURCE OF A HIGH VELOCITY SOLAR-WIND STREAM. Krieger, A. S. (American Science and Engineering, Cambridge, MA); Timothy, A. F.; Roelof, E. C. Solar Phys.; 29: No. 2, 505-525 (Apr 1973).

X-ray images of the solar corona, taken on November 24, 1970, showed a magnetically open structure in the low corona which extended from N20W20 to the south pole. Analysis of the measured x-ray intensities shows the density scale height within the structure to be typically a factor of two less than that in the surrounding large scale magnetically closed regions. The structure is identified as a coronal hole. Since there have been several predictions that such a region should be the source of a high-velocity stream in the solar wind, wind measurements for the appropriate period were traced back to the Sun by the method of instantaneous ideal spirals. A striking agreement was found between the Carrington longitude of the solar source of a recurrent high-velocity solar-wind stream and the position of the hole. Solar-wind bulk velocity and photospheric magnetic field data from the period 1962–1970 indicate the possible extension of the result to the interpretation of long term variations in the wind pattern. (auth)

16328 NONTHERMAL TURBULENT HEATING IN THE SOLAR ENVELOPE. Papadopoulos, Konstantinos (Institute for Fluid Dynamics and Applied Mathematics, University of Maryland). Astrophys. J. 179: No. 3, 939-947 (1 Feb 1973).

It is shown that MHD pulses, in the form of fast magnetosonic waves or solitons, can produce a strong electron–ion coupling capable of maintaining $T_e \approx T_p$ in the solar envelope ($r \lesssim 30 R_\odot$). The mechanism producing the nonthermal heating is the fluid-like modified two-stream instability, which, since it is essentially independent of the T_e/T_p ratio and the value of β, becomes a prime candidate for the anomalous collisions required by the fluid models inside $r \lesssim 30 R_\odot$, in order to explain the dominant features of the solar-wind flow. (auth)

16329 ELECTROSTATIC TURBULENCE AT COLLIDING PLASMA STREAMS AS THE SOURCE OF ION HEATING IN THE SOLAR WIND. Papadopoulos, Konstantinos (Institute for Fluid Dynamics and Applied Mathematics, University of Maryland,). Astrophys. J. 179: No. 3, 931-938 (1 Feb 1973).

We propose a mechanism for the nonthermal ion heating observed in colliding solar-wind streams at 1 a.u. based on an electrostatic, short-wavelength instability between the ions in the observed colliding plasma streams. The modes lying on a plane perpendicular to the magnetic field thermalize most of the differential energy. The model suggests local electrostatic turbulence, that α-particles are heated more than protons ($T_\alpha \approx 4T_p$), a maximum proton temperature $T_p \lesssim 10^6$ °K, and peak T_p where the change in the bulk speed is greatest. These predictions are consistent with observations. (auth)

16330 THE ENERGY SPECTRUM OF SMALL-SCALE SOLAR MAGNETIC FIELDS. Nakagawa, Y.; Priest, E. R. (High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado). Astrophys. J. 179: No. 3, 949-963 (1 Feb 1973).

On the basis of observations that magnetic flux is transported by fluid motions at the photospheric level of the Sun, the possible interpretation of the energy spectra of small-scale solar magnetic fields in terms of a passive response of the (longitudinal) magnetic field to turbulent fluid motions is examined. In consideration of the prevailing physical conditions, a theory is developed which accounts for the two-dimensional passive response of longitudinal magnetic fields to a three-dimensionally isotropic turbulent convection at the level of vanishing vertical velocity. The theoretical results are compared with the evergy spectra of small-scale magnetic fields obtained from longitudinal magnetograms for typical active, quiet, and mixed regions of the Sun. It is shown that the observed spectra can be interpreted in terms of the theory developed with the choice of eddy kinematic viscosity $\approx 10^{14}$ cm^2 s^{-1} and eddy magnetic diffusivity $\approx 10^{12}$ cm^2 s^{-1}, including differences in the spectral shape for different regions of solar activity. The details of the theory are described together with discussions on the limitations and other implications of the results. (auth)

16331 HIGH RESOLUTION RADIO OBSERVATIONS OF THE SUN AT 3.71 AND 11.1 CM. Hobbs, R. W.; Jordan, S. D.; Webster, W. J. Jr. (Goddard Space Flight Center, Greenbelt, MD). Nature (London) Phys. Sci.; 243: No. 125, 48-50(21 May 1973).

Observations of the Sun were made at 3.71 and 11.1 cm on January 14, 1972 using the National Radio Astronomy Observatory three-element interferometer in the 2.7–1.8–0.9 km configuration. There was evidence at 3.71 cm for structure in the active region with angular size at least as small as 2.8 arcs, and a correlated flux density of about 80 fu was indicated. At 11.1 cm there was structure in the same active region with angular size no greater than 8.5 arc s, with a correlated flux density of about 300 fu. During the period of observation a flare of importance 1N occurred near the east limb, and details are given of associated correlated flux and angular size. (UK)

16332 DEVELOPMENT OF MOVING TYPE IV SOLAR RADIO BURSTS AND RELATION TO EXPANDING MAGNETIC BOTTLES FROM FLARE REGIONS. Sakurai, K. (Goddard Space Flight Center, Greenbelt, MD). Nature (London) Phys. Sci.; 243: No. 125, 46-48(21 May 1973).

It is stated that wide-band type IV radio bursts are usually associated with solar proton flares. Emission of these bursts generally commences at microwave frequencies and later expands into decimetric and metric frequencies. The metric components at first tend to move outwards through the solar corona from the flare regions, and are often called "moving type IV m bursts." The time difference from microwave to metric emissions is dependent on the positions of associated flares with respect to solar longitude, and in general tends to become larger as the positions move eastwards from the west limb of the solar disk. The author analyzed observations of type IV bursts associated with proton flares to obtain the time difference as a function of the longitude positions of associated flares on the solar disk; the time difference was found to be highly dependent on longitude, and was larger on the eastern hemisphere. The E–W asymmetry may be explained by taking into account the configuration of sunspot magnetic fields and the movement of radio sources near the flare regions. An analysis was also made of the relation between peak flux intensity of moving type IV m bursts and the solar longitude of associated flares. Results indicated that the highest peak flux intensity is usually observed when a flare occurs in the region 10 to 40° west of the central meridian of the solar disk; this must be considered in discussing the center-to-limb change of the peak flux intensity of metric components of moving type IV bursts. It seems that in the initial stage of their development type IV radio bursts consist of two distinct parts, one stationary and confined to the high-frequency range, and the other classified as a moving type IV m burst in the metric and decametric frequency range. The latter usually follows a type II radio burst. The speed of a moving type IV m source, however, is very different from that of a type II burst. This suggests a difference in emission mechanism for these two bursts. Moving type IV m bursts are due to mildly relativistic electrons trapped by sunspot magnetic lines of force, near the flare regions, stretched outwards in a form of magnetic bottle. On the other hand, type II bursts are associated with expanding shock waves. (UK)

16333 PHOTOELECTRONS AND SOLAR WIND/LUNAR LIMB INTERACTION. Criswell, D. R. (Lunar Science Inst., Houston, TX). Moon; 7: No. 1-2, 202-238(1973).

It is suggested that boundary conditions for solar wind/lunar limb interactions are active. The "whole-Moon" limb does not evoke a shock cone because warm (≈13 eV/electron) solar-wind electrons are replaced by cool (≲2 eV/electron) photoelectrons that are ejected from the generally smooth areas of the lunar terminator illuminated at glazing angles by the Sun. A localized volume of low thermal pressure is created in the solar wind by these cool photoelectrons. The solar wind expands into this turbulence-suppressive volume without shock production. Conversely, directly illuminated highland areas exchange hot photoelectrons (>20 eV/electron) for warm solar-wind electrons. The hot electrons generate a localized pressure increase (Δp) in the adjacent solar-wind flow which evokes a shock streamer in the solar wind. Shock streamers are identifiable by a coincident increase in the magnitude ($\Delta B \sim \Delta p$) of the solar-wind magnetic field immediately external to the lunar wake. Shock occurrence is controlled by lunar topography, solar activity in the hard ultraviolet (>20 eV), solar-wind electron density and thermal velocity, and the intensity of the solar-wind magnetic field. (auth)

16334 STABILITY OF THE SOLAR SYSTEM: EVIDENCE FROM THE ASTEROIDS. Dermott, S. F.; Lenham, A. P. (Royal Military Coll. of Science, Swindon, Eng.). Moon; 5: No. 3-4, 294-301(1972).

An analysis of the distribution of the orbital periods of the asteroids has shown that there is a preference for these periods to be near-commensurate with that of Mars. It is suggested that this preference is associated with a formation process and im-

plies that the orbital period of Mars has not changed greatly since the time of asteroid formation. From this it is deduced that the solar system is highly stable and long-period gravitational perturbations have probably had little influence on the gross evolution of the solar system. (auth)

16335 WAKE OF THE MOON. Moskalenko, A. M. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 791-798(1972).

Translated from Kosm. Issled.; 10: No. 6, 871-878(1972).

The disturbances of the magnetic field and the particle concentration in the wake of the Moon are discussed. Analytic expressions are derived for the perturbations that hold at large distances in the plane passing through the velocity and magnetic-field vectors of the solar wind. The influence of the electric field due to charge separation and of the magnetic-field perturbations upon the motion of particles is taken into account. The field strength is shown to increase in the zone of rarefaction. In the perpendicular plane the perturbations experience three-dimensional damped oscillations, beginning at distances smaller than the radius of the Moon. (auth)

16336 SOLAR X RADIATION IN JULY, 1964 AND IN NOVEMBER AND DECEMBER, 1965 ACCORDING TO DATA FROM THE ELEKTRON-4 SATELLITE AND THE VENERA-2 PROBE. Letfus, V.; Tindo, I. I. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 838-842(1972).

Translated from Kosm. Issled.; 10: No. 6, 920-924(1972).

Results of measurements of the x-ray flux from the quiet Sun in the periods of July 11–22, 1964 and November 14–December 20, 1965 are cited. The measurements were made by photometers and Geiger counters mounted on the Élektron-4 satellite (0 to 8 and 8 to 14 Å) and on the Venera-2 probe (8 to 14 Å). The relation of the x radiation to the development of an active region and to chromospheric subflares during a period of solar-cycle minimum was monitored. (auth)

16337 THE DIFFERENTIAL ENERGY SPECTRA OF SOLAR-FLARE ^{1}H, ^{3}He, AND ^{4}He. Dietrich, William F. (Enrico Fermi Institute and Department of Physics, University of Chicago). Astrophys. J. 180: No. 3, 955-973 (15 Mar 1973).

The differential energy spectra of ^{3}He from the 1969 November 2 and 1971 January 25 flares have been measured by the University of Chicago charged-particle telescope on board the IMP 5 satellite in the energy range of ∼9 to 90 MeV nucleon^{-1}. Assuming a power-law spectrum in energy per nucleon, the spectral indices for the 1969 November 2 flare for protons, ^{4}He, and ^{3}He are, respectively, -2.47 ± 0.05, -3.5 ± 0.2, -1.9 ± 0.6; for the 1971 January 25 flare, -2.34 ± 0.05, -3.15 ± 0.2, -2.1 ± 0.8. For the 1969 November 2 flare, the ^{3}He/^{4}He abundance ratio in the energy interval 10–50 MeV per nucleon is $(7.7\pm2.0)\pm10^{-2}$, and for the 1971 January 25 flare this ratio is $(2.0\pm1.0)\times10^{-2}$. The presence of ^{3}He with spectra that are flatter than the ^{4}He spectra confirms the work of Hsieh and Simpson. The observation of the large ^{3}He/^{4}He ratio for these individual flares suggests a hypothesis of ^{3}He production by nuclear interactions and requires the additional hypothesis of acceleration at the flare site to compensate for energy loss by ionization. The observation of an average ^{3}He/^{4}He ratio of $\sim3\times10^{-3}$ for seven other flares in the same magnetic rigidity interval shows that the relative abundance of ^{3}He may vary by a factor of 4 from flare to flare. (auth)

16338 THE ROLE OF CONVECTION IN STELLAR ATMOSPHERES. I. OBSERVABLE EFFECTS OF CONVECTION IN THE SOLAR ATMOSPHERE. Travis, Larry D.; Matsushima, Satoshi (Department of Astronomy, Pennsylvania State University, University Park). Astrophys. J. 180: No. 3, 975-985 (15 Mar 1973).

A numerical method has been developed to apply Spiegel's theory of convection based on the generalization of the mixing-length formalism for model-atmosphere calculations. The method is used to construct solar model atmospheres under various physical conditions in order to investigate the effect of convective flux on various observable quantities. Due to the nonlocal effect of convective flux from deeper layers taken into account in Spiegel's theory, a significant increase in the observable effect of convection with an increase in the mixing length is seen as compared to that obtained from models based on the usual mixing-length theory. However, a comparison of predicted limb darkening with observations indicates that the ratio of mixing length to pressure scale height cannot exceed 0.35. As a result, the observable effect of convection appears to be negligible small in the atmospheres of the solar-type stars. (auth)

16339 APPLICATION OF STATISTICAL ADJUSTMENT OF DATA TO THE ENERGETIC SOLAR COSMIC RAY INCREASE OF NOVEMBER 18, 1968. Komori, H. (Tokyo Univ. of Fisheries); Suda, T.; Kodama, M. Sci. Pap. Inst. Phys. Chem. Res. (Jap.); 66: No. 4, 163-174(Dec 1972).

A method of "statistical adjustment of data" of Deming was applied to the analysis of the solar-flare increase in cosmic-ray intensity observed at ground level on November 18, 1968. Hourly data of neutron intensities from 26 cosmic-ray stations were utilized for this application. Four source parameters, latitude λ_s, longitude φ_s, power law exponent γ in spectral representation, and half angle $\theta_{1/2}$ of angular spread were determined by the least-square method of Deming. The calculations were made for each of the following two models of the asymptotic directions of approach of cosmic-ray particles: (A) the magnetosphere effect is introduced in addition to the internal magnetic field, and (B) no magnetosphere effect is taken into account. As a result, it is shown that four parameters determined for the model (A) are $\lambda_s = -13° \pm 7°$, $\varphi_s = -27° \pm 19°$, $\gamma = -6.7 \pm 1.8$ and $\theta_{1/2} = 43° \pm 7°$. No significant difference is found in these parameters between (A) and (B). A particular attention is paid to the precise determination of standard errors of the four parameters in order to compare the calculated values of increments with the observation data. (auth)

Galaxies

Refer also to abstracts 16249, 16254, 16280, 16294, and 16362.

16340 TIME-DEPENDENT MODELS FOR THE FORMATION OF INTERSTELLAR CLOUDS. Mansfield, Victor N. (National Astronomy and Ionosphere Center, Cornell University, Ithaca, New York). Astrophys. J. 179: No. 3, 815-822 (1 Feb 1973).

The time-dependent model for interstellar cloud formation of Schwarz, McCray, and Stein is extended to a three-dimensional treatment, the effect of an interstellar magnetic field is studied, and ultraviolet photoelectric heating from grains is included. The three-dimensional clouds are much denser and broader, but the presence of reasonable magnetic fields forces the compressional flow into sheets perpendicular to the magnetic field lines. The inclusion of grain heating reduces the density amplification by about one-half, but it also yields higher temperatures, broader clouds, and longer time spans over which the models approximate interstellar clouds. (auth)

16341 THE DEPENDENCE OF COMPTON X-RAY EMISSION FROM CLUSTERS OF GALAXIES ON THE VELOCITY DISPERSION OF THE CLUSTER. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, West Virginia). Astrophys. J. Lett. 180: No. 2, L49-L53 (1 Mar 1973).

In considering the expansion of radio sources in a cluster of galaxies, it can be shown that X-ray emission associated with such discrete sources arising from Compton interactions of the synchrotron electrons with the microwave background radiation depends on the parameters of the intracluster medium. By assuming that the mass of the intracluster gas is proportional to the virial mass of the cluster it is found that the X-ray luminosity of the cluster is related to the velocity dispersion of the member galaxies through the relation $L_{X\varnothing}\ (\Delta v)^{2/3(\gamma-1)}$. For an appropriate choice of electron spectral index γ the (L_X, Δv) relation noted by Solinger and Tucker can be reproduced. The implications of this result are discussed. (auth)

16342 GALACTIC MAGNETIC FIELDS: CELLULAR OR FILAMENTARY STRUCTURE?. Michel, F. C.; Yahil, A. (Institute for Advanced Study, Princeton, New Jersey, 08540). Astrophys. J. 179: No. 3, 771-780 (1 Feb 1973).

We have examined the possibility that the galactic field is composed of cells or filaments elongated by plasma motions or by the differential rotation of the galactic disk. Such cells could result from special events, and each would then contain its own independent magnetic-field structure. Our analysis of available data indicates that there is a significant correlation between the signs of the observed rotation measure between different radio sources as a function of their angular separation out to angles of about 40°. The anticorrelation expected for a uniform field component is absent, indicating that any uniform component would have to be an order of magnitude weaker than the ambient fields. One or more localized field "patches" seem indicated near $l^{II}=80°$, $b^{II}=0°$. We discuss these results in terms of a cellular field model. Cosmic-ray propagation would be sensitive to such structuring. Stars are also shown to be a potential source of very fine filamentary field (much less than a parsec in width) which would not be resolved in the rotation measure data, but which might account for the starlight polarization data. (auth)

16343 COSMIC-RAY HEATING AND MOLECULAR COOLING OF DENSE CLOUDS. Glassgold, A. E.; Langer, William D. (Department of Physics, New York University). Astrophys. J. Lett. 179: No. 3, L147-L151 (1 Feb 1973).

We estimate the heating by low-energy cosmic rays of molecular clouds whose main constituent is H_2 to be 19 eV per primary ionization. We determine the steady-state temperature as a function of density where H_2 and CO are responsible for cooling for a range of ionization rates and CO abundances. (auth)

16344 VARIATIONS IN SPECTRAL-ENERGY DISTRIBUTIONS AND ABSORPTION-LINE STRENGTHS AMONG ELLIPTICAL GALAXIES. Faber, S. M. (Harvard University). Astrophys. J. 179: No. 3, 731-754 (1 Feb 1973).

Thirty-one elliptical galaxies and 10 globular clusters have been

observed on a 10-color intermediate-band photometric system designed for the study of old stellar populations. To within the accuracy of the present data, the integrated colors of elliptical galaxies can be specified with only two independent parameters which in turn may be utilized to determine both the intrinsic colors and the reddening between the galaxy and the observer. The intrinsic colors and line strengths are closely correlated with absolute magnitude at all luminosities. (auth)

16345 THE DENSITY-WAVE THEORY OF GALACTIC SPIRALS. Piddington, J. H. (CISRO Division of Physics, National Standards Laboratory, Sydney, Australia 2008). Astrophys. J. 179: No. 3, 755-770 (1 Feb 1973).

Two questionable assumptions made two decades ago have persisted: that because there is no dust between the spiral arms of the Andromeda Galaxy there is no gas, and that the elongated features of cool gas (H I) seen in our Galaxy are parts of twin spiral arms. These have led to the wide acceptance of the belief that spiral arms are gas streamers, to the general abandonment of magnetic theories, and to the wide acceptance of the Lin-Shu density-wave theory. In the present paper these assumptions and their extensions have been tested in our Galaxy and some others. (auth)

16346 COURSE IN ASTRONOMY BY THE SOCIETE ASTRONOMIQUE DE FRANCE. 10. Galaxies-Universe. Oudenot, G. Astronomie; 87: 113-127(Mar 1973). (In French).

A definition is given of the galaxies. Their system of classification is presented together with the methods used to evaluate their distances and masses. They are then examined in the framework of cosmological hypotheses on the formation of the Universe. (FR)

16347 VARIABLE RADIO EMISSION FROM THE EXTRAGALACTIC SUPERNOVA 1970g IN M101. Goss, W. M. (State Univ., Groningen, Netherlands); Allen, R. J.; Ekers, R. D.; De Bruyn, A. G. Nature (London) Phys. Sci.; 243: No. 125, 42-44 (21 May 1973).

The variable radio source associated with the supernova 1970g in M101 has been mapped at Westerbork (21 and 6 cm) with the synthesis radio telescope, and at Effelsberg (2.8 cm) with the 100m telescope of the Max Planck Institute. Although there are as yet insufficient data to provide the basis for a unique theoretical model it is already possible to single out promising lines of attack. (auth)

16348 AN ATTEMPT TO DETECT RADIO EMISSION FROM MARKARIAN GALAXIES AT 408 MHz. Thomasson, P.; Malumian, V. H. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 295-297(1973).

Upper limits to the radio emission and luminosities at 408 MHz from 21 Markarian galaxies (Markarian, Soobshch. Bjurak. Obs.; 34: 3(1963); Astrofizika; 3: 55(1967); Astrofizika; 5: 443(1969), and Astrofizika; 5: 581(1969)) having either quasi-stellar and Seyfert characteristics or stellar-type spectra are reported. Observations of each galaxy were made at a large number of hour angles using the Jodrell Bank Mark I-Mark II interferometer. (auth)

16349 V-K COLOURS OF THE NUCLEI OF BRIGHT GALAXIES. Penston, M. V. (Hale Observatories, Pasadena, CA). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 359-366(1973).

Photometric observations of the nuclei of the galaxies M32, M33, M51, NGC5195, and M101 are reported. These give U-B, B-V, H-K, and V-K colors for each object and the K-L color for M32. No short-wavelength infrared excesses are found. For M32, published population models (Spinrad & Taylor, Astrophys. J. Suppl.; 22: No. 193 (1971)) predict a V-K color too red to be compatible with the observations. (auth)

16350 RADIO SCINTILLATIONS DUE TO PLASMA IRREGULARITIES WITH POWER LAW SPECTRA: THE INTERSTELLAR MEDIUM. Little, L. T.; Matheson, D. N. (Kent Univ., Canterbury, Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 329-338 (1973).

The scintillation effects which occur when radiation is incident on a medium containing phase changing irregularities which have a spatial frequency spectrum of power law form $P(S) \alpha S^{-n}$ are discussed for the case when the rms phase deviation is greater than one radian. An attempt is made to resolve the apparent discrepancies between the works of other authors who have tackled this problem, usually from the standpoint of ray optics. The theory is applied to the interstellar medium and it is shown that at spatial frequencies approximately corresponding to the derived correlation lengths the index n of the irregularity spectrum steepens from <2 to >4. The non-gaussian tails in the power spectra of interstellar scintillations noted by Lang (Science; 166: 1401(1969)) are probably due to random velocities in the medium rather than to the shape of the irregularity spectrum. (auth)

16351 INFRA-RED OBSERVATIONS OF NGC 7552 AND NGC 7582 AND THEIR IDENTIFICATION WITH PKS RADIO SOURCES. Glass, I. S. Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 35P-37P (1973).

JHKL fluxes are given for NGC 7552 and 7582 and upper limits on the JHK fluxes are obtained for NGC 7590. The identification of the first two of these with PKS 2313-428 and PKS 2315-426 is suggested. (auth)

16352 ORIGIN OF INTERSTELLAR MOLECULES. Shimizu, M. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 153-164(Jan 1973).

It is concluded from a thermochemical calculation that the interstellar molecules in compact H II regions may be formed in places of high temperature and high pressure. A possibility of the locations of molecular formation may be the prestellar atmospheres, but the atmospheres of late type stars are other possible candidates. Detectable interstellar molecules suggested from the above calculation are enumerated. A similarity of the composition of cometary atmosphere to that of the interstellar molecules is pointed out and its implication is briefly discussed. (auth)

16353 MEASURED EXTINCTION EFFICIENCY OF GRAPHITE SMOKE IN THE REGION 1200 TO 6000 A. Day, K. L.; Huffman, D. R. (Univ. of Arizona, Tucson). Nature (London) Phys. Sci.; 243: No. 125, 50-51(21 May 1973).

It is stated that the interstellar extinction curve has three significant features in the uv that must be accounted for by any successful model of the interstellar medium; these are a peak near 2200 Å ($\approx$4.6 μm^{-1}), a minimum in the 5.5 μm^{-1} to approximately 7 μm^{-1} range, followed by rising extinction into the far uv. It is significant that this extinction in the far uv is generally greater than that observed at the 4.6 μm^{-1} peak. To date no single species model has been found to match these features. Graphite has been proposed to account for the 4.6 μm^{-1} feature, but Mie calculations have shown that while graphite could produce the 4.6 μm^{-1} peak, it could not explain the continued rise into the far uv; in no case could the extinction rise above the 4.6 μm^{-1} peak. Recent work has indicated that stringent requirements must be placed on the graphite particles in order to produce this peak; the particles must be small (mean radius ~0.015 μm), spherical, and uncoated. The studies described are thought to be the first to present extinction measurements for graphite in the small particle form. The particles used were produced by striking an arc between graphite electrodes in He and allowing them to coat a SiO_2 of LiF substrate held a short distance from the arc. This technique facilitates measurements in the vacuum uv, and an electron microscope grid in contact with the substrate was used to collect particles for morphological studies. Both a synthetic graphite and a natural sample were used. Extinction measurements were made by comparing the intensity of light transmitted through the graphite coated substrate with that transmitted through an uncoated substrate of the same material; results are shown plotted. Vacuum uv measurements were made with a scanning monochromator. In the near uv short of the peak, agreement between the Mie theory for spheres and the experimental data was very poor. The region beyond 5.5 μm^{-1} on the experimental curve was very interesting and at great odds with the Mie theory, and it is thought that this theory may be inadequate for this region, and that graphite particles could account for the observed extinction. It is not, however, contended that graphite by itself accounts for all phenomena observed in the interstellar medium. (UK)

16354 INTERSTELLAR MOLECULES. Jefferts, K. B. (Bell Telephone Labs., Murray Hill, NJ). pp 353-361 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A review is given of various interstellar molecules and their location. (JFP)

Cosmology

Refer also to abstracts 16238, 16262, and 16299.

16355 (LA-tr-73-23) SHOCK WAVES AND MATTER. Michel, K. W.; Wagner, H. G. Transplanted from Naturwissenschaften; 58: No. 2, 65-77(1971). 45p. Dep. NTIS $4.25.

An attempt is made to describe the basic features of shock waves through condensed, gaseous, and disperse media, emphasizing developments from 1965 to the end of 1969, since the period prior to that is adequately covered by other review articles. Shock waves being a major tool for studying phenomena of matter under extreme conditions, the present experimental limits are outlined, and a brief account is given of the phenomena occurring at high-speed impact, in detonations and in astrophysics. (auth)

16356 OBSERVATIONAL CONSTRAINTS IMPOSED BY BRANS-DICKE COSMOLOGIES. Morganstern, R. E. (Lunar Science Institute, 3303 NASA Road 1, Houston, Texas 77058). Phys. Rev. D 7: No. 6, 1570-1579 (15 Mar 1973).

The flat-space Brans-Dicke (BD) Friedmann cosmologies previously found are analyzed in more detail. Further exact relations among the observable quantities ρ, H, $\dot{A}$ (fractional time variation of G), t, and q (deceleration parameter) are found and subsequently used to discuss the over-all consistency of the cosmological solution with the observed values of these quantities and their associated uncertainties. It is found that consistency with observables is possible over almost the entire range of the solution parameter z from 1 to ∞. The greatest upper bound on $\dot{A}_0$ which is marginally consistent with the other observables ($t_{galac}=7.3\times10^9$ yr and $t_H=19.5\times10^7$ yr is found to be $\dot{A}=3.85\times10^{-11}$/yr (for $z\simeq1.4$) and corresponds to a density of $\rho=1.95\times10^{-30}$ g/cm^3. Since in the $z\to1$ limit the curved- and flat-space solutions are identical, the above bound on $\dot{A}$ is also a reasonable one for curved space. In any case, the limiting values of $\dot{A}/H$ as $z\to1$ give a greatest upper bound on $\dot{A}$ for curved spaces, and one finds $\dot{A}_{max}=9.7\times10^{-11}$/yr for $t_H=13\times10^9$ yr. The previous "upper bound" $\dot{A}\simeq10^{-11}$/yr (for flat space) found by using the $z\to\infty$ solution is therefore actually an upper bound in terms of ϵ only. Finally the values for the deceleration parameter are found to range from q=0.538, 1.0 (for $\epsilon=0$, 1/3) to q=2.0 (all ϵ) as z goes from ∞ to 1. For the case of marginal consistency with the other observables ($z\simeq1.4$) one finds q=1.42, 1.52 for $\epsilon=0$, 1/3. This range of (flat-space) values for the deceleration parameter, consistent with other observables, indicates the nonexistence of a unique relation between the deceleration parameter and the sign of spatial curvature in the BD theory. (auth)

16357 DYNAMICS OF THE FRIEDMANN UNIVERSE USING REGGE CALCULUS. Collins, P. A.; Williams, Ruth M. (Physics Department, Imperial College of Science and Technology, London SW 7, England). Phys. Rev. D 7: No. 4, 965-971 (15 Feb 1973).

Models for the Friedmann universe are constructed from 5, 16, or 600 dust-filled tetrahedrons connected so as to form a closed space. Using the techniques of Regge calculus the time development of these model universes is determined and the results compared with the standard analytic solution for an isotropic dust-filled universe. (auth)

16358 SINGULARITIES OF THE COSMOLOGICAL MODEL OF THE BIANCHI IX TYPE ACCORDING TO THE QUALITATIVE THEORY OF DIFFERENTIAL EQUATIONS. Bogoyavlenskii, O. I.; Novikov, S. P. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1475-1494(May 1973). (In Russian).

An exact definition and calculation of all singular points (in the sense of qualitative theory of differential equations) are presented for the Einstein equations in an homogeneous cosmological model of the Bianchi IX type and for the separatrixes. This makes possible an exact statement and solution of the problem regarding the initial states of the Universe at early stages of evolution which are "typical" for the sign of time corresponding to expansion (in contrast to contraction for which the typical states have been found by Belinsky, Lifshitz, and Khalatnikov and the analytically complex structure of the cosmological singularity has been elucidated). The initial typical states for Universe expansion correspond asymptotically to power solutions with three types of time factor asymptotics: that of the Friedman quasi-isotropic type, that of the Taub type, and of a previously unknown type. (auth)

16359 ISOTROPIZATION OF HOMOGENEOUS COSMOLOGICAL MODELS. Doroshkevich, A. G.; Lukash, V. N.; Novikov, I. D. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1457-1474(May 1973). (In Russian).

A complete solution of the Einstein gravitational equations is presented for anisotropic homogeneous cosmological models with a hydrodynamic energy-momentum tensor. Isotropization of the solution during expansion is studied. It is shown that agreement with present-day astronomical observations should be possible only if expansion isotropization occurs at a very early stage. In Bianchi models of the VII type expansion isotropization involves curvature isotropization. In models of the IX type the solution in the general case becomes isotropic with respect to deformation but remains pronouncedly anisotropic with respect to the three-dimensional space curvature tensor. The problem of isotropy of relict radiation is considered. (auth)

16360 GRAVITATIONAL INSTABILITY OF REGULAR MODEL UNIVERSES IN A MODIFIED THEORY OF GENERAL RELATIVITY. Nariai, H. (Hiroshima Univ., Takehara, Japan). Progr. Theor. Phys. (Kyoto); 49: No. 1, 165-180(Jan 1973).

Any regular model-universe must be non-singular for an infinitesimal perturbation of the metric, if it exists at all. To examine this problem, the gravitational instability of regular isotropic model-universes in a modified theory of general relativity is investigated, whose gravitational Lagrangian is of the form $L_g = R-(1/6l^2)(l^2R)^n$, where l is a characteristic length such that $l \gtrsim 10^{7(2n-3)/(n-1)}$ cm (due to consideration of the solar gravitational field) and n is a numerical constant larger than unity. Dynamical equations for three independent wave modes (i.e., gravitational, rotational and longitudinal waves) classified by Lifshitz are derived and some characteristic features of these wave modes are touched upon. In particular, the temporal behavior of rotational waves allowable in the regular model-universes found by Breizman et al. ($p=\epsilon/3$) and Gurovich ($p=0$) in the case $n=\frac{4}{3}$ is studied in detail. It is shown that their amplitudes become singular at respective characteristic epochs, except in a special model-universe which cannot be applied to the real universe. Several possibilities to overcome such a difficulty are also discussed. (auth)

16361 NEWTONIAN UNIVERSES WITH NONLINEAR VELOCITY. Evans, A. B. (Univ. of Otago, New Zealand). Phys. Lett.; 44A: No. 3, 211-212(4 Jun 1973).

A generalization of the usual Newtonian cosmological principle permits homogeneous world models in which the velocity function contains nonlinear terms. (auth)

16362 CLUSTERS OF GALAXIES AND THE COSMIC LIGHT. Shectman, Stephen A. (Hale Observatories, California Institute of Technology, Carnegie Institution of Washington). Astrophys. J. 179: No. 3, 681-698 (1 Feb 1973).

Because galaxies cluster in space, the cosmic background light due to galaxies is not smoothly distributed on the night sky. Based on an explicit description of clusters of galaxies, spatial power spectra for the cosmic-light fluctuations are predicted. These spectra depend strongly on the luminosity density of the universe and the covariance structure of the galaxy distribution. They also depend somewhat on cosmological model. (auth)

16363 THE HUBBLE DIAGRAM FOR THE BRIGHTEST QUASARS. Bahcall, John N. (Institute for Advanced Study, Princeton, New Jersey, 08540); Hills, Richard E. Astrophys. J. 179: No. 3, 699-703 (1 Feb 1973).

The slope of the magnitude-redshift relation for the optically most luminous quasars with redshifts ranging from 0.2 to more than 2 is consistent with the value of 5 expected from the expansion of the universe if luminosities are evaluated assuming quasars are at the cosmological distances implied by their redshifts. (auth)

16364 NEW LIMIT ON SMALL-SCALE IRREGULARITIES OF "BLACKBODY" RADIATION. Parijskij, Y. N. (Leningrad Department of Special Astrophysical Observatory, Leningrad M140, Pulskovo, USSR). Astrophys. J. Lett. 180: No. 2, L47-L48 (1 Mar 1973).

There are no fluctuations of blackbody radiation above the 0.8×10^{-4}°K rms level at 2.8 cm wavelength on the scales 3'-1°. This new limit rejects Ree's model of the Universe filled by long-wavelength gravitational radiation and restricts some hypotheses of the origin of galaxies as well as clusters of galaxies. (auth)

16365 ON THE ORIGIN OF LIGHT ELEMENTS. Reeves, Hubert (SEP, CEN Saclay, France); Audouze, Jean; Fowler, William A.; Schramm, David N. Astrophys. J. 179: No. 3, 909-930 (1 Feb 1973).

A summary is given of the current beliefs regarding the origin and history of the light elements ^{2}D, ^{3}He, ^{4}He, ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, and ^{11}B in the universe. A description of the various sites of nucleosynthesis for these elements is given, and the results compared with observations. It is found that the galactic cosmic rays (GCR) can spallogenically produce ^{6}Li, ^{9}Be, and ^{10}B as well as the bulk of the ^{11}B (perhaps all) and $\approx$10 percent of the ^{7}Li. The deuterium can only be produced pregalactically either in the big bang or in some pregalactic event. The big bang or pregalactic events will also produce ^{3}He and ^{4}He and some ^{7}Li. Additional ^{7}Li (and possibly even some ^{11}B) can be synthesized during the helium-flash stage in red giants. Stellar synthesis might also add ^{3}He to the galactic gas. (auth)

16366 OPERATIONAL APPROACH TO THE ENERGIES OF GRAVITATIONAL WAVES. Tammelo, R. (Tartu State Univ.). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 22: No. 2, 207-209(1973).

An attempt is made to compare the angular distribution of the energy flux ensuing from the Landau-Lifschitz pseudotensor, on the one hand, and the angular distribution of the energy of gravitational waves directly available to detectors, on the other. It was found that in the case of a weak gravitational field and monochromatic waves the angular distributions coincide for the time-averaged pseudotensor, and for a special two-dimensional detector. As the energy absorbed by a detector has a clear-cut physical meaning, it follows that the time-averaged pseudotensor gives the correct angular dependence of gravitational energy flux. (WDM)

16367 HOYLE'S ELECTRODYNAMIC VERSION OF THE STEADY-STATE COSMOLOGY. Burman, R. R. J. Proc. Roy. Soc. N. S. W.; 104: 121-122(1972).

Hoyle once published a version of the steady-state cosmology, based on Proca's equations, in which separation of matter and antimatter produces an intergalactic magnetic field. Here, the

constants in that theory are evaluated by using recent results on intergalactic Faraday rotation. (auth)

16368 KINEMETRIC INVARIANTS AND THEIR RELATION TO THE CHRONOMETRIC INVARIANTS OF EINSTEIN'S THEORY OF GRAVITY. Zel'manov, A. L. (State Astronomical Inst., Moscow). Dokl. Akad. Nauk SSSR; 209: No. 4, 822-825(1973). (In Russian).

Chronometric invariants with their fixed time lines, the mathematically advantageous quantities called kinemetric invariants were found to be related by means of Christoffel's three-dimensional symbol operators and the use of Einstein's equations of the gravitational field. (KSW)

16369 ROTATION AND DISTORTION OF THE UNIVERSE. Collins, C. B.; Hawking, S. W. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 162: No. 4, 307-320(1973).

The isotropy of the microwave background is used to place upper limits on the large-scale anisotropies of the Universe. This is done by considering the behavior of the microwave background in all types of spatially homogeneous models that could reasonably represent the Universe. If the Universe is closed, it is found that it is rotating at a rate of less than 3×10^{-11} second of arc/century if the microwave background was last scattered at a redshift of about 7 and less than 2×10^{-14} second of arc/century if the last scattering was at a redshift of 1000. It is also calculated how far back in time the Universe must have been nearly isotropic. In the case of one extreme hyperbolic model, it seems that it could have been highly anisotropic at a redshift greater than about 4. The significance of these results for galaxy formation is briefly discussed. (auth)

16370 COSMIC ABUNDANCE OF BORON. Cameron, A. G. W.; Colgate, S. A.; Grossman, L. (Yeshiva Univ., New York). Nature (London); 243: No. 5404, 204-207(25 May 1973).

Cosmic abundance of boron is of considerable interest, but is difficult to determine. Boron undergoes thermonuclear destruction in stellar interiors, and hence is not a normal product of stellar nucleosynthesis. Thus its abundance is low, and until now it has seemed possible to understand its production in nature as a consequence of cosmic-ray bombardment of the interstellar medium. It is pointed out here that the cosmic abundance of boron has been greatly underestimated, and that the upward revision of its abundance has important consequences in several areas of astrophysics. (auth)

16371 FOCUSING OF GRAVITATIONAL RADIATION INTO THE GALACTIC PLANE. Lawrence, J. K. (Department of Physics, Northeastern University, Boston, Massachusetts 02115). Phys. Rev. D 7: No. 8, 2275-2277 (15 Apr 1973).

We consider rays of gravitational radiation emitted near the event horizon of a maximally rotating black hole at the galactic center, aligned with the galactic rotation. If the emitting matter is concentrated in the equatorial plane of the black hole, the focusing effect of the metric will be concentrated in the galactic plane. An average intensification of about an order of magnitude results at the earth. (auth)

16372 POST-NEWTONIAN GRAVITATIONAL EFFECTS IN LUNAR LASER RANGING. Nordtvedt, Kenneth Jr. (Montana State University, Bozeman, Montana 59715). Phys. Rev. D 7: No. 8, 2347-2356 (15 Apr 1973).

The dominant-range perturbations of the lunar orbit are calculated in relativistic gravitational theory, the results being applicable to all metric theories of gravity (a class of theories which includes general relativity). By searching for the various effects calculated in this paper using lunar laser ranging, the several parametrized post-Newtonian coefficients of the metrical gravitational field can be determined, thus pointing toward specific relativistic, post-Newtonian theories of gravity and empirically ruling out other theories. (auth)

16373 QUANTIZED MATTER FIELDS AND THE AVOIDANCE OF SINGULARITIES IN GENERAL RELATIVITY. Parker, Leonard; Fulling, S. A. (Department of Physics, University of Wisconsin—Milwaukee, Milwaukee, Wisconsin 53201). Phys. Rev. D 7: No. 8, 2357-2374 (15 Apr 1973).

We consider a classical gravitational field minimally coupled to a quantized neutral scalar field possessing mass. We are especially concerned with the effects of particle creation and quantum coherence on the premises and conclusions of the singularity theorems, which imply the inevitability of singularities in classical general relativity. A closed Robertson-Walker geometry is used throughout. Nongravitational interactions are not considered. The source of the gravitational field in the Einstein equations is the expectation value of the energy-momentum tensor of the quantized scalar field. Lacking a general prescription for obtaining a finite operator from the divergent formal expression for the energy-momentum tensor, we confine our attention to situations in which plausible special methods are available. We show that quantum coherence effects in this semiclassical model can result in a violation of the energy conditions which enter into the singularity theorems. Then we exhibit numerical solutions of the coupled Einstein and scalar field equations in which a Friedmann-like collapse is stopped and converted to a Friedmann-like expansion. (In this calculation one mode of the quantum field was assumed dominant.) We conclude that quantum effects of the type considered here can sometimes lead to avoidance of the cosmological singularity, at least on the time scale of one Friedmann expansion. (auth)

16374 RELATIVISTIC MANY-BODY THEORY FOR STRONGLY INTERACTING MATTER. Bowers, Richard L. (Center for Relativity Theory, The University of Texas at Austin, Austin, Texas 78712); Campbell, John A.; Zimmerman, Robert L. Phys. Rev. D 7: No. 8, 2278-2288 (15 Apr 1973).

The relativistic many-body theory for the equation of state describing a strongly interacting system of baryons in flat space-time is presented. After giving the coupled equation of motion for relativistic Green's functions, which include finite density and temperature as boundary conditions, we develop relativistic expressions for the pressure and the energy density of the interacting system in terms of the fermion two-point function. The latter is expressed by an integral equation, which includes the pseudoscalar coupling to lowest order in the coupling constant. The result is regularized, and renormalization to both physical and effective mass and charge is discussed. The expressions obtained serve as the basis for a numerical calculation of the equation of state which is presented in the follower paper. A significant feature of our results is a fully relativistic equation of state which includes interactions, and which leads to an asymptotic limit for the speed of sound $v_s \leq c/\sqrt{3}$. (auth)

16375 MODEL EQUATION OF STATE FOR STRONGLY INTERACTING SUPERDENSE MATTER. Bowers, Richard L. (Center for Relativity Theory, The University of Texas at Austin, Texas 78712); Campbell, John A.; Zimmerman, Robert L. Phys. Rev. D 7: No. 8, 2289-2299 (15 Apr 1973).

The equation of state for a zero-temperature system of strongly interacting baryons is calculated. Interactions, described by the exchange of a pseudoscalar meson, are treated relativistically to lowest order in the coupling constant. The finite density of the ground state is included through a fully relativistic many-body theory discussed in a previous paper. The results, which are applicable to a single-component system of baryons for densities 10^{13} g/cm$^3 < \rho$, lead to an upper limit for the speed of sound $v_s \leq c/\sqrt{3}$. Simple analytic expressions are given which fit the results of numerical computation in the density range 10^{13} g/cm$^3 \lesssim \rho \lesssim 10^{23}$ g/cm^3. (auth)

16376 EVALUATION OF THE DIRECTIVITY OF GRAVITATIONAL WAVE RADIATORS. Seki, Hideo (5-11-3 Kamiuma, Setagaya, Tokyo, Japan); Obata, Tsunehiro; Chiba, Jiro. J. Appl. Phys. 44: No. 5, 2401-2407 (May 1973).

A method of evaluation of the directivity of gravitational wave (GW) radiators is given in the form of general equations applicable to most cases such as Weber's apparatus and the travelling wave (TW) -type radiator (the latter proposed by one of the authors). Although it is not generally accepted now, Einstein's weak-field theory is used for evaluating both near and distant fields. In a numerical example, using our general formula, the TW-type radiator is considered and it is found that a half-power angle width of $\pm 5.3°$ is feasible using a crystal 30 cm in length. Intensity comparison is also made between the resonance vibrator and TW-type radiators. Under reasonable assumptions, the radiated power of the latter is about 10^{23} times larger than the former —that means 10^{40} times higher intensity than the spinning rod first considered by Einstein as a GW source. (auth)

Planetary Phenomena

16377 PHOTOMETRIC STUDY OF THE COUNTERGLOW FROM SPACE. Roach, F. E. (Rutgers-The State Univ., Newark, NJ); Carroll, B.; Aller, L. H.; Roach, J. R. Planet. Space Sci.; 21: No. 7, 1179-1184(Jul 1973).

Photometric observations of the region of the counterglow (Gegenschein) made from OSO-6 are examined. The observations were made during the September-October 1970 period when the counterglow was between the Milky Way arms at a relatively high (negative) galactic latitude. The lines of sight included a slice across the anti-Sun region at an inclination of 48° to the ecliptic. A comparison is made between the photometric gradients as measured from the spacecraft and similar gradients deduced from ground-based observations. (auth)

16378 PHOTOMETRIC PERTURBATION OF THE COUNTERGLOW. Roach, F. E. (Rutgers-The State Univ., Newark, NJ); Carroll, B.; Roach, J. R.; Aller, L. H. Planet. Space Sci., 21: No. 7, 1185-1189(Jul 1973).

A weakening of the radiance of the counterglow in the anti-solar direction relative to the regions 5° to 15° away is interpreted as

evidence for a cloud of scattering material in the general region of the Earth–Moon system. Further evidence is indicated, by the relative brightening at –180° in the vicinity of the L4 libration point, that the cloud is significantly denser there than in adjacent locations. (auth)

16379 INVESTIGATION OF THE GAMMA EMISSION OF LUNAR SOIL BROUGHT BACK BY THE AUTOMATIC STATION LUNA-16. Surkov, Yu. A.; Fedoseev, G. A.; Sobornov, O. P. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 855-859(1972).

Translated from Kosm. Issled.; 10: No. 6, 938-942(1972).

A low-background scintillation gamma spectrometer with anticoincidence shielding was used to determine the amounts of natural radioelements (K, U, Th) and long-lived cosmogenic radioisotopes (^{26}Al, ^{22}Na, ^{54}Mn) in a regolith sample from Mare Fecunditatis. The analyzed sample (coarse-grained material containing rock fragments and other particles) weighed 10 g and was taken from the central part of the core brought back by Lune-16. The natural radioelement data are used in an attempt to classify the investigated sample in the scale of petrochemical types of terrestrial rocks arranged according to their silicic acid content and alkalinity. Within the framework of the potassium–uranium classification of lunar samples the K/U ratio for the sample obtained from Mare Fecunditatis is compared with corresponding data from other lunar regions. Questions relating to the vertical distribution of cosmogenic radioisotopes in the regolith are also discussed. (auth)

16380 NONDISPERSIVE X-RAY FLUORESCENCE ANALYSIS IN INVESTIGATIONS OF COSMIC AND TERRESTRIAL MATERIAL. Surkov, Yu. A.; Andreichikov, B. M.; Akhmetshi, I. K.; Khristianov, V. K.; Shevaleevskii, I. D. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 848-854(1972).

Translated from Kosm. Issled.; 10: No. 6, 930-937(1972).

The advantages of using an α-particle source instead of a tritium source as a substitute for an x-ray tube in a crystal-free x-ray spectroscopic method of analyzing the chemical composition of samples are discussed. The results of determination of the elemental composition of some rock types, and also of the lunar soil sample brought back by the Soviet automatic station Luna-16, are given. A method of this kind is shown to be suitable for analysis of the chemical composition of space material by apparatus carried on automatic stations. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 16300.

16381 (SC-TM-720716) MODELING THE CHEMICAL KINETICS OF THE STRATOSPHERE. Hudson, F. P. (Sandia Labs., Albuquerque, N. Mex). Jun 1973. 49p. Dep. NTIS $3.00.

A tutorial development of atmospheric processes important to the chemical kinetics of the stratosphere is presented. In parallel, the mathematical simulation of the total interaction of these processes – a chemical kinetics model – is developed. The solar flux – atmosphere interaction is sketched; the energy states of the oxygen molecule are discussed as an example for atmospheric molecules; the build-up of a set of atmospheric species and reactions is shown stepwise; and resultant families of reactions shown. The physical – mathematical foundation of the model, coupled continuity equations, is demonstrated, and examples of the types of results obtainable from calculations are given. The sample results are for a model using 33 atmospheric species composed of oxygen, nitrogen, hydrogen, and carbon atoms, with 170 chemical reactions among the species. The paper is a transcription of a lecture presented for the purpose of introducing the physics and chemistry of the stratosphere, and the related mathematical modeling, to scientists of other disciplines. (auth)

16382 LUNAR TIDAL OSCILLATIONS IN THE HORIZONTAL IONOSPHERIC DRIFT AT THE EQUATOR. Misra, R. K. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci., 21: No. 7, 1109-1114(Jul 1973).

The effect of lunar tides on the apparent ionospheric drift velocity (V) for an equatorial station Thumba (0.6°S dip) is computed by using nearly six years of data at fixed solar hours. Significant tides are observed in the E-region drifts, particularly around 12.00 hr and in the F-region drifts around 15.00 hr. A good correlation in the phases of the lunar tides in H and V is found to exist, suggesting a strong electrojet control of the horizontal ionospheric drift around these hours. (auth)

16383 BALLOON OBSERVATION OF AURORAL X-RAYS AT SYOWA STATION, ANTARCTICA. Measurements for the Geomagnetic Conjugacy. Kodama, M. (Inst. of Physical and Chemical Research, Wako, Japan); Ogura, K.; Tamai, E.; Oguchi, T. Rikagaku Kenkyusho Hokoku; 48: No. 6, 145-165(Nov 1972). (In Japanese).

To explore physical characteristics of auroral x rays caused by precipitating electrons onto the polar regions, particularly in terms of the geomagnetic conjugacy, a series of balloon flights for observation of the auroral x rays was carried out at Syowa Station, Antarctica. During a month from the middle of January 1968, 10 plastic balloons were launched from there, and about 11 events of distinct x-ray bursts were detected. Three flights out of ten were simultaneous with some of balloon flights from Reykjavik, Ireland, being very close to the exact conjugate point of Syowa Station. Some physical features in regard to day-night difference of the geomagnetic conjugacy between the two sited were solved in this way. Furthermore, the energy spectrum of the distinct x-ray bursts and its time variation were investigated in association with other related geophysical phenomena. (auth)

16384 TIME DEPENDENT STUDIES OF THE AURORA. 2. Spectroscopic Morphology. Rees, M. H.; Jones, R. A. (Univ. of Colorado, Boulder). Planet. Space Sci.; 21: No. 7, 1213-1235(Jul 1973).

The temporal morphology of auroral spectral emission features is investigated. For a given energy distribution of bombarding electrons but a time varying flux magnitude, the emission rates of various auroral radiations exhibit a nonlinear time response due to the variety of reactions that contribute to excitation. Absolute intensities and intensity ratios of various spectroscopic features, therefore, can vary solely with atmospheric interaction effects, indicating the importance of considering the time history of a precipitation event when attempting to infer the characteristics of auroral electrons from optical measurements. (auth)

16385 AURORAL ION VELOCITY DISTRIBUTIONS USING A RELAXATION MODEL. St-Maurice, J. P.; Schunk, R. W. (Yale Univ., New Haven). Planet. Space Sci.; 21: No. 7, 1115-1130(Jul 1973).

For application to the auroral ionosphere the ion velocity distributions have been calculated for a weakly-ionized plasma subjected to crossed electric and magnetic fields. By replacing the Boltzmann collision integral with a simple relaxation model, it has been possible to obtain an exact solution to Boltzmann's equation. This solution has the advantage over a series expansion in that all the higher order velocity moments are inherent in it. The exact solution is particularly advantageous when studying large departures of the distribution from its Maxwellian form because these departures are caused by the higher velocity moments. In general, however, a simple relaxation model can only be used to obtain qualitative information on the distribution function. Consequently, it is possible to determine when the higher order velocity moments affect the ion velocity distribution and the nature of their effect, but it is not possible to obtain accurate quantitative results. The higher velocity moments have their greatest effect on the distribution function above about 120 km, where the ion-neutral collision frequency is less than the ion cyclotron frequency. As the magnitude of the electric field increases, these higher moments act to decrease the number of ions at the peak of the distribution function. Peak densities are reduced by a few percent for perpendicular electric fields of about 20 mV m^{-1}. (auth)

16386 ORIENTATIONAL DEPENDENCE OF CERTAIN RF IMPEDANCE PROBES IN THE IONOSPHERE. Bishop, R. H. (Utah State Univ., Logan). Planet. Space Sci.; 21: No. 7, 1262-1267(Jul 1973).

In an effort to determine electron density and temperature from RF impedance probe measurements, Bishop and Baker (Planet. Space Sci.; 20: 997-1013(1972)) derived an expression using a quasi-static approximation for the impedance of an electrically short cylindrical antenna in a warm magnetoplasma. The problem was limited to the case where the longitudinal axis of the antenna was aligned with the magnetic field. The purpose of this paper is to remove this restriction on the orientation angle of the antenna by using a perturbation technique valid when either ω or ν is much larger than the electron gyrofrequency. Under these conditions it is found that the antenna impedance has no dependence upon the antenna orientation angle. Although still somewhat restrictive, this result is useful for the whole class of RF probes in which the driving frequency is well above the upper hybrid resonance frequency. (auth)

16387 THERMOSPHERIC OBSERVATIONS COMBINING CHEMICAL SEEDING AND GROUND-BASED TECHNIQUES. 2. Ionospheric Drifts and the Sq Current System. Rees, D. (University Coll., London); Haerendel, G.; Felgate, D. G.; Lloyd, K. H.; Low, C. H. Planet. Space Sci.; 21: No. 7, 1237-1249(Jul 1973).

Two Skylark sounding rockets carrying chemical seeding payloads were launched from Woomera, South Australia in October 1969. In conjunction with these firings, the F-region drifts were determined with the Buckland Park aerial array and the results compared with the observed motion of the barium ion clouds. The local ionospheric Sq current system was calculated both from the observed ionospheric parameters and from ground-based magnetograms and the differences between the two results are discussed. (auth)

16388 INTERNATIONAL PROGRAMS FOR STRATOSPHERIC STUDIES. Joatton, R. Aeronaut. Astronaut. (Paris); No. 40, 67-92(Mar 1973). (In French).

The increases envisaged in stratospheric transport have stimulated research into the nature of the stratosphere by various countries (United States, Great Britain, and France). The different programs are summarized. A report of the Australian Academy of Science on stratospheric flights is presented in an appendix. (FR)

16389 THEORY OF CHARGED PARTICLE TEMPERATURES IN THE UPPER ATMOSPHERE. Schunk, R. W.; Walker, J. C. G. (Yale Univ., New Haven). Progr. High Temp. Phys. Chem.; 5: 1-62(1973).

The subject is dealt with in sections: electron temperature (heating, cooling, thermal conduction, mid-latitude electron temperatures, auroral electron temperatures); ion temperature (heating, cooling, thermal conduction, mid-latitude ion temperatures, auroral ion temperatures). (UK)

16390 RADIATION PRESSURE AND RELATED FORCES. Smith, W. E. J. Proc. Roy. Soc. N. S. W.; 104: 143-149(1972).

The phenomenon of radiation pressure is introduced and briefly surveyed. The Larmor theorem and the adiabatic theorem are used to deduce expressions for radiation pressure, and to show

that radiation pressure is a normal concomitant of wave propagation. Electromagnetic radiation pressure is discussed in some detail using the author's generalized steady force theory for arbitrary loss-free systems. This approach emphasizes the unity of radiation pressure, and quasi-stationary forces, regarded here as related forces. It is shown that the generalized adiabatic theorem includes the content of much previous theoretical work. Practical applications are also discussed. A similar formulation is given for acoustics leading to a corresponding generalized adiabatic theorem. Radiation pressure effects in oceanography are mentioned briefly but not discussed in detail. (auth)

16391 EXPLORING POSSIBILITIES OF RADAR OBSERVATION OF NONLINEAR WAVE INTERACTION IN IONOSPHERIC PLASMA. Gusev, G. A.; Kushnerevskii, Yu. V. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 866-867(1972).

Translated from Kosm. Issled.; 10: No. 6, 950(1972).

Natural plasma oscillations were employed in order to explain the resonance phenomena observed on ionograms taken of the upper ionosphere. (WDM)

16392 LIGHT FLASH CREATED IN THE UPPER ATMOSPHERE BY A PULSED SOURCE OF X RAYS. Zhemerev, A. N.; Medvedev, Yu. A.; Stepanov, B. M. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 834-837(1972).

Translated from Kosm. Issled.; 10: No. 6, 916-919(1972).

The characteristics are discussed of the light flash stimulated in the upper atmosphere by a pulsed x-ray source having a Planck spectrum with $kT \sim 1$ keV. It is shown that in the case of a distant source the time parameters of the light flash depend slightly on the temperature of the radiation and the zenith distance of the source. (auth)

16393 APPROXIMATE ANALYTIC SOLUTIONS OF THE DIFFUSION EQUATION FOR JACCHIA'S STATIC UPPER-ATMOSPHERE MODELS. Degtyarev, M. A. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 820-823(1972).

Translated from Kosm. Issled.; 10: No. 6, 901-904(1972).

Approximate analytic solutions were obtained for the diffusion equation corresponding to Jacchia's static upper-atmosphere models. These approximations agreed with the 1965 model to within 2%, and with the 1970 model to 10%. The density profiles of Jacchia's upper-atmosphere models were compared. (auth)

16394 DIRECT INVESTIGATIONS OF THE DISTRIBUTION OF SPACE CHARGES AND FIELDS AT ALTITUDES TO 90 km. Bragin, Yu. A.; Kocheev, A. A. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 816-819(1972).

Translated from Kosm. Issled.; 10: No. 6, 897-900(1972).

Investigation of the space-charge and field polarities in the stratosphere and the mesosphere by means of rockets is described. The data obtained in rocket investigations indicate that the polarities of the space charge and the field change with altitude and that the distribution of these quantities is virtually constant in time in the approximate range from 20 to 60 km. Below 20 and above 60 km, however, they change considerably. It is noted that, above 20 to 30 km, the absolute value of the density of the vertical atmospheric conduction current can reach or exceed 10^{-9} A · m^{-2}, which is much larger than the vertical current density in the troposphere. (auth)

16395 ION-DENSITY FLUCTUATIONS AT HEIGHTS OF 200 TO 1300 km IN THE IONOSPHERE. Borisov, S. I.; Nikolaev, V. D. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 811-896(1972).

Translated from Kosm. Issled.; 10: No. 6, 892-896(1972).

Measurements of the number density of ions were made with instruments carried by the Kosmos 434 satellite on three distinct orbits differing in apogee height. The experimental results afford an estimate for the influence of the Earth's shadow on the level of ion density. The provisional conclusion is reached that as the height at the shadow boundary increases in the morning hours (local time), the zone of reduced density may shift into the sunlit region of the ionosphere and the extent of the zone may increase. (auth)

16396 FURTHER MEASUREMENTS OF THE SUBMILLIMETER BACKGROUND AT BALLOON ALTITUDE. Muehlner, Dirk J.; Weiss, Rainer (Research Laboratory of Electronics and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. Lett. 30: No. 16, 757-760 (16 Apr 1973).

Mesurements of the far-infrared background radiation were made with a balloon-borne radiometer at an altitude of 44 km. Equivalent blackbody temperatures of $2.55^{+0.25}_{-0.45}$, $2.45^{+0.45}_{-1.05}$, and $2.75^{+0.8}_{-2.75}$ °K were obtained for the background radiation in bandwidths extending from 1 to 11.5, 13.5, and 18.5 cm^{-1}. The total measured flux in the largest bandwidth is dominated by the atmospheric emission by ozone and water. The radiation of these atmospheric components was determined independently in a separate pair of radiometer spectral responses. (auth)

Magnetospheric Phenomena

Refer also to abstract 17252.

16397 (NP-19814) PITCH ANGLE DISTRIBUTIONS IN AND NEAR THE LOSS CONE OF (100 TO 350) keV PROTONS. Scientific/Technical Report No. 52. Amundsen, R. (Bergen Univ. (Norway). Dept. of Physics). Jan 1973. 28p. Dep. NTIS $3.50.

The pitch angle distributions in and near the loss cone, of ~(100 to 200) and ~(200 to 350) keV protons observed by the ESRO IB satellite during the period October 7–15, 1969 are presented. The data include periods of relative quiet as well as more disturbed geomagnetic conditions. Spatial characteristics and dynamics of the protons, both on the night and day side of the Earth are described. The actual pitch angle distribution is interpreted as produced by wave-particle interactions, and the diffusion coefficient and lifetime against pitch angle scattering have been estimated from existing theories. During slightly disturbed conditions, the observations suggest an average random walk in pitch angle made by a particle during a crossing of the diffusion region of about one half of the loss cone half angle for $4 \leq L \leq 6$. The lifetime against pitch angle scattering into the loss cone is found to be somewhat less than the charge-exchange lifetime for these (100 to 350) keV protons. The spectral density of interacting waves is tentatively estimated to be about 0.1 γ^2/Hz, and compares fairly well with estimates arrived at from completely different approaches. (auth)

16398 (UCRL-51385) LLL ELECTRON AND PROTON SPECTROMETER ON NASA'S ORBITING GEOPHYSICAL OBSERVATORY 5. West, H. I. Jr.; Buck, R. M.; Walton, J. R. (California Univ., Livermore. Lawrence Livermore Lab). 29 May 1973. Contract W-7405-eng-48. 66p. Dep. NTIS $5.50.

The LLL energetic electron and proton spectrometer on NASA's Orbiting Geophysical Observatory 5 (OGO-5) operated successfully from launch—March 4, 1968—until retirement in August 1971. Data recovery during this time was about 95% of the orbit except for the last few months. The electron spectrometer used a magnetic field for electron momentum selection which served also as an electron broom for a proton range–energy telescope. The energy range was ~60 to 2950 keV for electrons (seven channels) and 0.10 to ~94 MeV for protons (seven channels). The experiment was scanned relative to the stabilized OGO-5 for obtaining directional information. Excellent data were taken throughout the magnetosphere and in the interplanetary region (apogee 24 R_E). Studies were carried out in the areas of equatorial pitch-angle distributions, substorm dynamics and field topology, particle spectra (time history), particle spatial distributions, and solar particle events. Excellent data were available from other OGO-5 experiments for data correlation. Instrumentation features that contributed significantly to the experiment's success are described, and a resumé of the experimental results is presented. (auth)

16399 OBSERVATIONS OF COLLISIONLESS DRIFT WAVES. LaQuey, Robert E. (University of California, San Diego, La Jolla, California 92037). Phys. Fluids 16: No. 4, 550-558 (Apr 1973).

Velocity distribution functions of both the electron and the proton component of the magnetospheric plasma are measured in 62 logarithmically spaced steps from 50 eV to 50 keV by an instrument carried upon the ATS-5 spacecraft in circular synchronous orbit (6.6 earth radii). Oscillations which appear to be collisionless drift waves having periods of several minutes or longer are found in this data. Linearized wave theory can be use to predict the theoretical perturbation distribution function f_T in terms of the perturbing fields and the equilibrium distribution function F. The functional dependence of the theoretical perturbation distribution function f_T upon particle energy can then be compared with that of the measured perturbation f_M. The linear wave theory is found to predict correctly a change in the sign of f_M which occurs at a critical particle energy e^* and the relative magnitude of f_M over the entire energy range. (auth)

16400 SOLAR WIND INTERACTION WITH THE EARTH'S MAGNETOSPHERE. Kovner, M. S. (Gorky State Univ., USSR); Feldstein, Y. I. Planet. Space Sci.; 21: No. 7, 1191-1211(Jul 1973).

Hydrodynamic and electrodynamic problems of solar-wind interaction with the Earth's magnetosphere on the day-side are investigated. The initial fact, well established, is that the density of the magnetic field energy in the solar wind is rather small. Magnetic field intensity and orientation are shown to determine

the character of the solar-wind flow around the magnetosphere. For mean parameters of the wind, if the tangential component of the magnetic field is more than or equal to 5γ, the flow in the magnetosheath will be laminar. For other cases the flow is of a turbulent type. For turbulent flow, typical plasma parameters are estimated: mean free path, internal scale of inhomogeneities, and dissipated energy. The results obtained are compared with experimental data. For the case of laminar flow, special attention is paid to the situation when magnetic fields of the solar wind and Earth are antiparallel. It is suggested that the southward interplanetary field diffuses from the magnetosheath into the Earth's magnetosphere. It is shown that during magnetospheric substorms relaxation oscillations with the period τ = 100 to 300 sec must appear. A theorem is proved about the appearance of a westward electrical field during the substorm development, when the magnetosphere's day-side boundary moves Earthward and about the recovery phase, when the magnetopause motion is away from the Earth, when there is an eastward electrical field. In the Appendix, plasma wave excitation in the magnetopause is considered and conductivity magnitudes are calculated, including the reduction due to the scattering by plasma turbulence. (auth)

16401 DETERMINATION OF THE PROTON DENSITY IN THE MAGNETOSPHERE FROM OBSERVATIONS OF Pc3 TYPE GEOMAGNETIC PULSATIONS. Cavaciuti, N.; Glangeaud, F.; Lacoume, J. L. (Univ., Grenoble, France). Compt. Rend., Ser. A, B; 276: No. 14, 631-634(2 Apr 1973). (In French).

The density distribution of protons was calculated at the equator for the case when the lines of force of the Earth's magnetic field situated in the same meridian plane oscillate with the same period. The profiles obtained from the satellites and the latitude distribution of the periods observed from the Earth appear to satisfy the preceding resonance conditions. In this way a new manner of investigating the magnetosphere is proposed. (FR)

16402 SEMI-ANNUAL MODULATION OF EARTH'S MAGNETIC FIELD IN THE EQUATORIAL ELECTROJET REGION. Bhargava, B. N.; Rao, D. R. K.; Arora, B. R. (Indian Inst. of Geomagnetism, Bombay). Planet. Space Sci.; 21: No. 7, 1251-1255(Jul 1973).

Autospectra in the 2 to 13 month range, computed from mean monthly horizontal intensity on quiet days at Trivandrum, situated close to the dip equator, suggest an exceedingly large semi-annual modulation of the field confined to an interval of about 5 hr centered at 1000 LT. The amplitude of the semi-annual oscillation at this station, derived from power density, is greater than 19 γ at 1000 LT. Between 1900 and 0500 LT, spectral lines, corresponding to a period of six months, are not observed above the continuum. Spectral densities from observations at two other electrojet stations in India, Kodaikanal and Annamalainagar, and at Alibag, outside the electrojet, establish the existence of an appreciable enhancement of the semi-annual oscillation of the field in the equatorial electrojet belt. Similar computations of spectra using observations on all days, however, suggest a secondary component in the evening sector. This component is not enhanced in the equatorial electrojet belt. It is concluded that while in low latitudes the daytime component is largely associated with the modulation of Sq currents, in the electrojet belt it appears to be due entirely to a semi-annual modulation of the equatorial electrojet. It is also concluded that the secondary component, observed in the evening sector in low latitude and equatorial stations, is associated purely with the modulation of the ring current by disturbance. The two components of the semi-annual variation observed at the Indian stations have also been noticed at several stations between geomagnetic latitudes N54.6° and S41.8°. It is also observed that the association of the semi-annual component with geomagnetic latitude is confined to the evening–night component. (auth)

16403 SOLAR DIAMETER AT 5000 A AND Hα FROM PHOTOELECTRIC DRIFT SCANS. Whittmann, A. (Univ.-Sternwarte, Goettingen, Ger.). Solar Phys.; 29: No. 2, 333-340(Apr 1973).

An improved method is described for the measurement of both the solar radius and the height of the chromosphere in any desired wavelength. Possible sources of uncertainty are discussed and a comparison with other methods is made. The first results from the 1972 observing period are given: R = (960.24 ± 0.16)″ for the continuum at 5011.5 Å and R = (966.9 ± 0.4)″ for Hα ± 0.5 Å. This yields a mean height of Hα emission of (4900 ± 400) km. (auth)

16404 DEMARCATION LAYER IN THE MAGNETOSPHERE. Bobrov, M. S. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 799-806(1972).

Translated from Kosm. Issled.; 10: No. 6, 879-887(1972).

Both geometrical arguments and observational data, whether direct or indirect, support the existence of a demarcation layer in the magnetosphere separating the core of the magnetosphere from the northern and southern halves of the magnetotail. The demarcation layer borders with the daytime magnetopause along demarcation strips through which the solar-wind plasma penetrates from the transition region into the interior of the magnetosphere, aided by the joining of lines of force frozen into the solar plasma with the lines of force of the magnetosphere. The reconnections of the lines of force seem to occur in both the southward and northward directions of the interplanetary magnetic field. The demarcation layer is the layer of least resistance in the magnetosphere to the movement of the solar plasma, and hence any further flow of the plasma takes place within that layer, partly in the earthward direction, into the daytime sectors of the polar ovals, and partly sweeping around the Earth, into the neutral layer of the magnetotail. Seasonal variations of the angle ψ between the mass velocity vector of the solar wind and the normal to the magnetopause at the point of influx must lead to appreciable seasonal variations in the earthward flow of plasma through the northern and southern polar cusps. (auth)

16405 THEORY OF THE DIURNAL VARIATIONS OF THE EARTH'S MAGNETIC TAIL. Ershkovich, A. I.; Sobolev, S. V. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 807-810(1972).

Translated from Kosm. Issled.; 10: No. 6, 888-891(1972).

A study was made of the diurnal variations of the geomagnetic tail caused by the Earth's magnetic axis precessing about the axis of rotation. The tail is regarded as a plasma cylinder that is separated from the solar wind by a surface of tangential discontinuity. The calculated amplitudes of the variations agree with satellite measurements. (auth)

16406 POSITION OF THE DAYSIDE OF THE MAGNETOPAUSE. Kovner, M. S.; Rudneva, N. M.; Fel'dshtein, Ya. I. Cosmic Res. (USSR) (Engl. Transl.); 10: No. 6, 785-790(1972).

Translated from Kosm. Issled.; 10: No. 6, 864-870(1972).

It is shown from the observations carried out on board the IMP, OGO, and ATS satellites on the position of the magnetopause that the computed distances to the subsolar point of the magnetosphere boundary agree with the measured values, under the assumption that the regular magnetic field in the southward direction diffuses from the transition region into the magnetosphere. The penetration of the southward magnetic field is confirmed by measurements near the magnetopause since the measured field intensities are lower than the theoretical values by an amount equal to the magnitude of the magnetic field of the transition region. The distances to the subsolar point of the magnetosphere boundary are computed for different values of the parameters of the solar wind. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstract 17228.

16407 EIKONAL METHOD IN THE THREE-BODY PROBLEM. Dubrovskii, G. V.; Bogdanov, A. V. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1581-1588(May 1973). (In Russian).

Some properties of the first terms of the general eikonal expansion obtained by the authors in the three-body problem are investigated. A numerical calculation of the angular distribution of protons experiencing charge exchange with hydrogen atoms is carried out and is found to agree with the experiments (on the total cross section) and with the data of other authors. (auth)

16408 THEORETICAL STUDIES OF ATOM-SOLID ELASTIC SCATTERING: HE+LIF. Wolken, George Jr. (Abteilung Molekularstrahlphysik, Max-Planck-Institut für Strömungsforschung, 3400 Göttingen, Böttingerstrabe 6/8, Federal Republic of Germany). J. Chem. Phys. 58: No. 7, 3047-3064 (1 Apr 1973).

The elastic scattering of an atom from a solid surface is considered in the close-coupling formulation. The resulting sets of coupled differential equations are solved by a technique developed by Gordon and previously applied to atom-molecule inelastic scattering. For the example of He+LiF, utilizing the Lennard-Jones, Devonshire model potential, it is shown that basis sets consisting of only low order diffraction channels can be seriously in error. Results are presented using typically 29 coupled channels but as many as 41 channels are included for individual cases. Several calculations including only five coupled channels are also presented. These results are shown to be very useful in interpreting the causes of various effects seen in the 29 channel computations even though providing a poor over-all approximation to the 29 channel results. Various diffraction processes (with emphasis on the specular intensity) are studied as functions of the coupling between the specular and diffracted beams, the incident direction, and for the two isotopes He^3, He^4. The direct numerical approach used here automatically includes the effect of bound state resonances. These are seen to have a significant effect on the specular intensity. This is found to be the usual behavior at the threshold for the first nonspecular channel, but can also occur when there are already many channels open. Many of the trends observed in experimental data are also observed in the present results. (auth)

16409 ADIABATIC ENVELOPE CONSERVATION IN CONE FOCUS TRAJECTORIES. Olson, Craig L. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Fluids 16: No. 4, 539-544 (Apr 1973).

The envelope of the adiabatic trajectory solution for particle motion that occurs in cone focusing of intense relativistic electron beams is investigated. Comparisons with exact trajectory envelopes (obtained numerically) show that the adiabatic envelope is an excellent approximation under a wide variety of circumstances. Consequently, several important effects are disclosed: (1) The axial dependence of the breakdown (and not the radial dependence) is explicitly shown to determine the focusing, (2) increasing the cone angle rapidly leads to increased losses, (3) angular momentum created by scatter in the anode foil typically should not cause significant losses, and (4) increase of the beam temperature along the cone axis is demonstrated. A novel explanation of "adiabatic envelope conservation" is included. (auth)

16410 CONE FOCUSING OF INTENSE RELATIVISTIC ELECTRON BEAMS. Olson, Craig L. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Fluids 16: No. 4, 529-538 (Apr 1973).

An analytic theory, embodying an axially-dependent breakdown model, is presented to explain the focusing experienced by an intense relativistic electron beam upon its injection into a gently-tapered, metallic guide tube (cone) filled with a neutral gas. The mechanism of cone focusing is thereby believed to be identified for the first time. The theory predicts the relative efficiency, relative fluence gain, energy loss along the cone, pressure variation, and cutoffs, with full dependence on the beam, cone, and neutral gas parameters. The theory is in good agreement with experiment. It is emphasized that the axially-dependent nature of the breakdown must be considered to explain the focusing; in addition, it is shown why image charges, image currents, or specular reflections can not explain the focusing. (auth)

16411 OBSERVATIONS WITH ORIENTED NUCLEI OF ONE-ELECTRON ATOMS OF F^{19}. Sprouse, G. D.; Brenn, R.; Calvin, H. A.; Metcalf, H. J. (Department of Physics, State University of New York, Stony Brook, New York 11790). Phys. Rev. Lett. 30: No. 10, 419-422 (5 Mar 1973).

Substantial nuclear orientation of excited F^{19} has been preserved in flight through vacuum at velocities where only a few electrons remain bound. Identification of the fraction of atoms with one electron has been made by applying a weak field and observing the effect of the atomic precession in flight on the γ-ray angular correlation. (auth)

16412 PIERCE ELECTRODES FOR A CYLINDRICAL BEAM OF RELATIVISTIC ELECTRONS. Vecheslavov, V. V.; Kononov, V. I.; Meshkov, I. N. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 8, 1413-1416(Aug 1972).

Translated from Radiotekh. Elektron.; 17: No. 8, 1775-1777 (Aug 1972).

Calculations for the design of Pierce electrodes for a cylindrical beam of relativistic electrons, which take into account the self-focusing action of the magnetic field of the beam, are given. (WHK)

16413 POLARIZED ELECTRON SOURCES. Kessler, J. (Univ., Muenster, Ger.). pp 523-541 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A survey of working methods for producing polarized electron beams is presented. The utility of these sources is compared. (auth)

16414 PROGRESS WITH POSITRON BEAMS FOR ATOMIC COLLISIONS. Keever, W. C.; Jaduszliwer, B.; Paul, D. A. L. (Univ. of Toronto). pp 561-571 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A schematic representation is shown of the positron beam apparatus. A broad, energy-analyzed positron beam can be routinely produced in which one has 5000 particles per minute. (JFP)

16415 LOW-ENERGY ION BOMBARDMENT OF SILICON DIOXIDE FILMS ON SILICON. McCaughan, Daniel V.; Murphy, Vincent T. (Bell Telephone Laboratories, Murray Hill, New Jesrey 07974). J. Appl. Phys. 44: No. 5, 2008-2017 (May 1973).

Exposure of SiO_2 layers on silicon to a plasma environment during sputtering or backsputtering leads to degradation of the electrical properties of the interface. In this paper the effects of the ion bombardment occurring during such exposure are detailed. A low-energy ion-bombardment apparatus, capable of giving ion beams ranging from 100 nA at 10 eV to 5 μA at 3.0 keV of mass-analyzed gas ions, constructed for this study, is described. Bombardment of SiO_2 layers by Ar^+, N^+, or N^+_2 ions of any energy from 10 to 2800 eV leads to increase in interface state density and oxide interface charge. The oxide charge after bombardment is located both in the region of the Si/SiO_2 interface and in the outside 50 Å of the SiO_2. Both induced oxide interface charge and interface state density increase linearly with dose to a saturation value, typically to 8×10^{12} charges/cm^2 and 10^{13} interface states/cm^2 eV at midgap after a dose of 8×10^{13} ions/cm^2 at 600 eV, on 1000Å of SiO_2. At constant dose the induced charge and interface state density increase linearly with energy to approximately 500 eV, then are independent of energy to the maximum energy studied. After ion bombardment to a dose of ions of 5×10^{13}/cm^2 or greater, SiO_2 films exhibit a significant reduction in dielectric strength. This reduction is not completely recoverable by annealing to temperatures up to 600 °C. Annealing to 600 °C does, however, remove all interface charge, interface states, and room-temperature trapping instabilities produced by the bombardment, as measured at room temperature after annealing. These experiments show that ion bombardment is capable of producing MOS degradation similar to some of the MOS degradation observed after sputter deposition of metals over oxide films. The increase in charge and interface states is a function of dose, so adjustment of plasma parameters during sputtering to give minimum ion bombardment should minimize this buildup of charge. (auth)

Atomic and Molecular Properties

Refer also to abstract 15269.

16416 STARK EFFECT IN HYDROGEN AND PRECISION MEASUREMENTS OF THE RYDBERG CONSTANT. Blackman, J. A.; Series, G. W. (Univ. of Reading, Eng.). J. Phys., B (London); 6: No. 6, 1090-1096(Jun 1973).

The determination of the Rydberg is based on the measurement of the wavelengths of suitable fine structure components in the spectra of one-electron atoms. A source of possible systematic error is the Stark effect arising from electric fields present in the discharge tube. A detailed analysis is given of the Stark effect on the Balmer-α line of the isotopes of hydrogen. The frequency

shifts and intensity changes are displayed for values of the electric field from 0 to 300 V cm^{-1}. (auth)

16417 EXPERIMENTAL DETERMINATION OF THE RYDBERG CONSTANT. Kibble, B. P. (National Physical Lab., Teddington, Eng.); Rowley, W. R. C.; Shawyer, R. E.; Series, G. W. J. Phys., B (London); 6: No. 6, 1079-1089(Jun 1973).

The wavelengths of components of the Balmer-α line in deuterium and tritium were determined in terms of the ^{86}Kr 606 nm primary standard to establish a value for the Rydberg constant. Improved resolution of the fine structure was achieved by using a discharge cooled in liquid helium to reduce the Doppler width. Positions and intensities of the fine structure components were found by analysis of the spectral line profiles. Variation of the discharge conditions produced no effects which could be correlated with predictions of Stark effect theory. The fine structure of tritium was found to be the same as that of deuterium to within experimental error and the isotope shift was satisfactorily described by the reduced mass factor. The value of the Rydberg constant was found to be $R_\infty = 109\ 737.326 \pm 0.008\ cm^{-1}$. The estimated error is to be understood as one standard deviation. The result is based on measurements of the three strongest components in the deuterium fine structure. (auth)

16418 MEASUREMENTS OF THE THERMAL DIFFUSION COEFFICIENT FOR ELECTRONS IN HELIUM. Gibson, D. K. (Australian National Univ., Canberra); Crompton, R. W.; Cavalleri, G. J. Phys., B (London); 6: No. 6, 1118-1128(Jun 1973).

The thermal diffusion coefficient for electrons in helium at room temperature was measured in order to obtain an independent check of experimental and theoretical momentum transfer cross sections that have recently been published. An adaptation of Cavalleri's method was used which avoids the possibility of errors due to drift induced by surface potentials within the diffusion cell. The value of the diffusion coefficient obtained confirms the cross section derived from other transport data and indicates that the theoretical cross sections are about 5% low. The fact that the measurement is made in the absence of an electric field makes this confirmation particularly valuable since the determination of the cross section does not rely on approximations that are usually made when transport theory is applied to make a similar determination from mobility measurements. (auth)

16419 CALCULATION OF THE ENERGY AND PROPERTIES OF THE HYDROGEN MOLECULE USING THE METHOD OF MOMENTS. Armour, E. A. G. (Nottingham Univ., Eng.). Mol. Phys.; 25: No. 5, 993-1010(May 1973).

The ground state energy and expectation values of several operators for the hydrogen molecule are calculated using the method of moments. The variation of binding energy with the internuclear distance was also calculated. It is shown that when the expansion functions used on the right are capable of fitting the ground state eigenfunction very accurately, accurate results for the energy and properties are usually, but not always, obtained. (auth)

16420 TRANSLATIONAL FACTORS IN EIKONAL APPROXIMATION AND THEIR EFFECT ON CHANNEL COUPLINGS. Chen, J. C. Y. (Comision Nacional de Energia Atomica, San Carlos de Bariloche, Argentina); Ponce, V. H.; Watson, K. M. J. Phys., B (London); 6: No. 6, 965-981(Jun 1973).

The coupled equations of the adiabatic-state expansion formulated in the context of the stationary-state scattering theory are examined. The translational factors are introduced in the eikonal approximation through coordinate transformation. The equations are consistent with those of Chen and Watson (Phys. Rev.; 174: 152-64(1968)) in that they are free from the spurious long-range interaction even in the absence of the translational factors. The cancellation of the spurious R^{-1} long-range interaction of the $2p\sigma_u - 2p\pi_u$ rotational coupling in the (p^+,H) system is given as an example. The effect of the translational factor on the channel coupling interaction is discussed. (auth)

16421 FINE STRUCTURE OF THE 2 ^3P STATE OF THE HELIUM ATOM. Corsaro, Felicia A.; Hameka, Hendrik F. (Department of Chemistry, University of Pennsylvania, Philadelphia, Pennsylvania 19104). J. Chem. Phys. 58: No. 7, 2851-2854 (1 Apr 1973).

The fine structure of the 2 ^3P state of the He atom depends on the spin–spin and spin–orbit interactions. It follows from the experimental splittings that the matrix element of the spin–spin interaction is 0.052767 cm^{-1} and the matrix element of the spin–orbit interaction is $-0.196519\ cm^{-1}$. We calculated the spin–spin interaction from a simple correlated wavefunction that may be used also for more complex systems. Our result is 0.053614 cm^{-1}; this agrees with the experimental value to within 1.8%. We found that our correlation wavefunction is not particularly suitable for calculating the spin–orbit coupling. (auth)

16422 SELF-CONSISTENT-FIELD ATOMIC ORBITALS FOR ATOMS AND IONS OF THE SECOND TRANSITION SERIES. Richardson, James W.; Blackman, Mark J.; Ranochak, James E. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). J. Chem. Phys. 58: No. 7, 3010-3017 (1 Apr 1973).

A systematic set of analytic atomic orbitals (AO's) is presented, which spans the atoms and principal ions of the second transition series elements in ground states of the configurations $(Kr)4d^n, 0 \le n \le 10$. The s and p AO's are expanded in a minimum set of Slater type orbitals (STO's); the chemically and spectrally more significant d orbitals are represented by four STO's. All coefficients and STO exponents have been chosen to minimize the nonrelativistic self-consistent-field total energy. Various computed energies are compared with experiment and with similar quantities obtained from earlier Hartree–Fock results for the corresponding first-row elements. The results indicate that the 4d AO's have sufficient accuracy to make them reliable in studies of spectra and bonding in compounds of these elements. (auth)

16423 LIFETIME AND ALIGNMENT OF THE 5^1D_2 STATE OF ^4He BY BEAM-FOIL LEVEL CROSSING. Yellin, J.; Hadeishi, T.; Michel, M. C. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. Lett. 30: No. 10, 417-419 (5 Mar 1973).

The lifetime of the 5^1D_2 state of ^4He was measured by the beam-foil, zero-field, level-crossing techniques. The result is compared with measurements based on conventional beam-foil and level-crossing methods. A multiparameter least-squares reduction of the data was used to determine the alignment in addition to the lifetime, thus eliminating the need for the separate measurements to determine the alignment. (auth)

16424 FACTORIZATION OF THE SCHROEDINGER RADIAL EQUATION FOR THE HYDROGEN ATOM AND THE PROPERTIES OF RADIAL INTEGRALS. Savukinas, A. Yu.; Chizhyunas, A. R. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; XIII: No. 1, 45-50(1973). (In Russian).

By the use of the factorization procedure of the Schroedinger radial equation for the hydrogen atom the relations between hydrogenic radial wave functions with orbital quantum numbers l and $l \pm 1$ are obtained. Making use of these relations properties of the radial integrals including the electrostatic as well as magnetic interactions are deduced. (auth)

For abstracts of individual papers see: 16260, 16354, 16413, 16414, 16426–16437, 16467–16477, 16488–16491, 17309, and 17310.

16425 ATOMIC PHYSICS. III. Proceedings of the Third International Conference, Boulder, Colorado, August 7-11, 1972. Smith, S. J.; Walters, G. K.; Volsky, L. H. (eds.). New York; Plenum Publishing Corporation (1973). 685p. (CONF-720857-). $29.50.

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972).

Separate abstracts were prepared for 33 of the 43 papers presented. The remaining papers were outside the subject scope of NSA. (JFP)

16426 $g_{j/(H)}g_{s/(e)}$ DETERMINATION: PRELIMINARY RESULTS. Tiedeman, J. S.; Robinson, H. G. (Duke Univ., Durham, NC). pp 85-91 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The ratio of g factors of the electron bound in the 1S state to that of the free electron is determined experimentally so that the leading mass-independent correction terms can be checked. (JFP)

16427 HIGHLY EXCITED STATES OF HELIUM AND NEON. Wing, W. H.; Lea, K. R.; Lamb, W. E. Jr. (Yale Univ., New Haven). pp 119-141 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The microwave-optical resonance method is used to study the microwave spectra of the high states of singly excited helium and microwave resonances in highly excited neon. (JFP)

16428 THEORETICAL STUDY OF ATOMIC RYDBERG STATES. Poe, R. T. (CERN, Geneva); Chang, T. N. pp 143-153 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A theoretical study is made on the electrostatic fine structure of the Rydberg series for atomic helium within the framework of the Brueckner–Goldstone many-body perturbation theory. The dipole polarization, screening and quadrupole polarization effects and the exchange terms are noted. Tables showing the contribu-

tions of diagrams to level shifts, the dipole contribution evaluated in the adiabatic approximation, level shifts and doublet splittings, and level transition energies and doublet splittings are presented. (JFP)

16429 FINE STRUCTURE AND HYPERFINE STRUCTURE OF THE HELIUM NEGATIVE ION. Mader, D. L.; Novick, R. (Columbia Univ., New York). pp 169-180 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Preliminary fine structure and hyperfine structure measurements were made in the helium negative ion with the isotopes helium-3 and -4. The values for the fine structure intervals are found from the transitions. (JFP)

16430 RECENT ADVANCES IN THE INTERPRETATION OF COMPLEX ATOMIC SPECTRA. Goldschmidt, Z. B. (National Bureau of Standards, Washington, DC). pp 221-246 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A review is given of various recent systematic investigations on the effects of the mutual magnetic and effective interactions on the energy level structure of heavy atoms. Effective electrostatic spin-orbit interactions in nsnp configurations, spin-dependent interactions in l^N configurations, and two- and three-electron effective electrostatic interactions in $l^N l'$ configurations are treated. (JFP)

16431 RADIATIVE DECAY OF THE METASTABLE STATES OF THE H AND He SEQUENCES: THEORY. Drake, G. W. F. (Univ. of Windsor, Ont., Can.). pp 269-290 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A review is given of the theory for the spontaneous radiative decay of the metastable states and the effects induced by a perturbing electric field. The levels of hydrogen and helium and some astrophysical applications are discussed. (JFP)

16432 RADIATIVE DECAY OF THE METASTABLE STATES OF H AND He SEQUENCES: EXPERIMENTS. Marrus, R. (Univ. of California, Berkeley). pp 291-308 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The experimental properties of the four known levels in the spectra of one- and two-electron atoms which can decay predominantly by other than an allowed El transition are reviewed. (JFP)

16433 IONIZATION OF EXCITED ATOMIC PARTICLES BY ELECTRIC FIELDS. Il'in, R. N. (Ioffe Inst. of Physics and Tech., Leningrad). pp 309-326 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

A review of electric field ionization of atoms applied for the detection of excited long-lived states of atoms and ions, the determination of the population of these states, and the measurement of the bound energy of electrons in these states is given. Hydrogen atoms and ions and helium ions are discussed. (JFP)

16434 BEAM RESONANCE MEASUREMENTS OF ATOMIC QUADRUPOLE MOMENTS. Sandars, P. G. H.; Stewart, A. J. (Oxford Univ.). pp 429-434 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Measurements of quadrupole moments are extended to the $^3P_2$ metastable states of the rare gases. Results for neon, argon, krypton, and xenon are given. (JFP)

16435 RECENT ADVANCES IN HELIUM OPTICAL PUMPING. Brossel, J. (Ecole Normale Superieure, Paris). pp 435-461 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Experiments dealing with optical pumping in helium are reviewed. The topics cover relaxation of the 2^3S_1 state, ground and excited state nuclear orientation, nuclear magnetic relaxation of ^3He, 1^1S_0, metastability exchange relaxation, charge-exchange collisions, and collisions affecting the n^1D_2 states. (JFP)

16436 ORIENTATION OF SHORT-LIVED MERCURY ISOTOPES BY MEANS OF OPTICAL PUMPING DETECTED BY β AND γ RADIATION. Bonn, J.; Huber, G.; Kluge, H. J.; Koepf, U.; Kugler, L.; Oten, E. W.; Rodriguez, J. (CERN, Geneva). pp 471-476 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The isotope shifts and asymmetries were measured for the mercury isotopes 205, 199^m, 192, 187, 185, and 183. (JFP)

16437 EXCITED ATOMIC AND MOLECULAR STATES IN LIQUID HELIUM. Fitsimmons, W. A. (Univ. of Wisconsin, Madison). pp 477-492 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The review of the electronic excitations of liquid helium includes energy levels, emission and absorption spectra, the blue shift, inverse concentration, the bilinear reaction coefficient, and potential curves for certain states of He_2. (JFP)

16438 DISTORTED-ATOMS-IN-MOLECULES MODEL FOR ORDINARY COVALENT MOLECULES. I. DESCRIPTION OF MODEL; CONNECTION WITH DISTINGUISHABLE ELECTRON METHOD; AND ILLUSTRATIVE APPLICATION TO H_2, LIH, AND BEH^+. Kirtman, B.; Chang, S. Y.; Scott, W. R. (Department of Chemistry, University of California, Santa Barbara, California, 93106). J. Chem. Phys. 58: No. 8, 3304-3314 (15 Apr 1973).

A simple, but accurate, unrestricted orbital product approximation for the spatial electronic wavefunction of ordinary covalent molecules is developed. Each orbital consists of a pure atomic function which is rescaled in the molecule and, then, polarized by a variable effective internal field. Thus, the molecular orbitals are expressed in terms of known atomic polarization functions. Illustrative calculations on H_2, LiH, and BeH^+, utilizing single Slater-type orbitals as the undistorted atomic functions, give 50%-75% of the maximum possible energy improvement over the restricted Hartree-Fock model. It is shown how our distorted-atoms-in-molecules (DAM) approximation can be employed together with the distinguishable electron perturbation method to determine first-and second-order physical properties to within about 10%. We also express the hope that the error in computed electron correlation energies can be reduced to less than 1 kcal/mole per electron pair. Of course, DAM may be used directly to estimate physical properties with medium (~40%) accuracy. (auth)

16439 DISTINGUISHABLE ELECTRON METHOD (DEM) FOR ELECTRONIC STRUCTURE CALCULATIONS. V. STATIC POLARIZABILITY OF H_2 IN THE SCREENED VALENCE BOND (WANG) APPROXIMATION. Scott, William R.; Kirtman, Bernard (Department of Chemistry, University of California, Santa Barbara, California, 93106). J. Chem. Phys. 58: No. 8, 3315-3319 (15 Apr 1973).

The distinguishable electron method is used to calculate the static polarizability tensor of H_2, at three different internuclear distances, starting with the screened valence bond (Wang) initial approximation. As usual, a first-order correlation correction is obtained by means of accessible expressions which do not require correlated wavefunctions. Since the polarization potential is linear in the Cartesian electron coordinates, the one-electron molecular perturbation functions can be determined exactly from pure atomic equations. Our results are comparable to the coupled Hartree-Fock values, but are obtained much more easily. Finally, it is shown that nonsymmetric perturbation treatments, which ignore exchange, are unsatisfactory because of large errors in determining the first-order correlation correction. (auth)

16440 VARIATIONAL CALCULATIONS ON FESHBACH-TYPE RESONANCE STATES OF THREE-ELECTRON ATOMS. Eliezer, I.; Moualem, A. (Institute of Chemistry, Tel-Aviv University, Tel-Aviv, Israel). J. Chem. Phys. 58: No. 8, 3466-3467 (15 Apr 1973).

The possible application of the MCEB method (for two-electron Feshbach resonances) to calculate the energies of resonance states of three-electron atoms is discussed. As an illustration, the method is applied to the $1s\,2s^2\ ^2S$ resonance of He$^-$. The value obtained is improved by CI stabilization procedures. (auth)

16441 ELECTRON BINDING ENERGIES OF URANIUM. Park, Robert L.; Houston, J. E. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Rev. A 7: No. 5, 1447-1451 (May 1973).

Soft-x-ray appearance-potential spectroscopy has been used to determine the binding energies of the N_4–N_7, O_1–O_5, and P_1–P_3 levels of clean uranium surfaces. This is the first direct determination of most of these levels. The measured energies of the N and O levels are consistently a few electron volts lower than tabulated x-ray binding energies based on photoelectron spectroscopy of oxidized uranium. Exposure of clean uranium to oxygen, however, did not appreciably shift the appearance potentials. It is suggested that the discrepancy is in part a consequence of a "surface chemical shift." The density of 5f states above the Fermi energy was found to be double peaked with a peak separation of 2.5 eV. (auth)

16442 STATE OF AN ELECTRON–HYDROGEN–ATOM SYSTEM IN AN INTENSE ELECTROMAGNETIC FIELD. Fabre, Bernard (Commissariat à l'Energie Atomique, Centre d'Etudes de Limeil B.P. n° 27–94–Villeneuve–Saint–Georges, France). Phys. Rev. A 7: No. 5, 1489-1493 (May 1973).

A general approximation method is developed to find the state of a system composed of a low–energy free electron and hydrogen atom in an intense electromagnetic field. The electron wave function includes two parts: one, of infinite extension, represents a free–electron state in an electromagnetic field; the other, localized on the atom, is a bound pseudostate. This method complements and takes its place among other known methods used for weak electromagnetic fields or high–energy electrons. It can be applied to interaction scalar potentials which decrease faster than $1/r$. (auth)

16443 FINE STRUCTURE OF PARA–H_2 D(3P) $^3\Pi_U$ (V=0–3) VIA MICROWAVE OPTICAL MAGNETIC RESONANCE INDUCED BY ELECTRONS. Freund, Robert S.; Miller, Terry A. (Bell Laboratories, Murray Hill, New Jersey 07974). J. Chem. Phys. 58: No. 9, 3565-3573 (1 May 1973).

The MOMRIE (microwave optical magnetic resonance induced by electrons) spectrum of para–H_2 d(3p) $^3\Pi_u$ has been measured in vibrational levels v=0–3 for the lowest rotational state (N=1). The theory previously used to analyze the MOMRIE spectrum of ortho–H_2 is also used here, but with the addition of terms to account for the effects of the magnetic and electric susceptibilities. Least squares fits of the MOMRIE spectral lines provide values of the so–called spin–orbit and spin–spin coupling constants, the orbital g factor, and the susceptibilities. Comparison of these values with corresponding values for ortho–H_2 reveals significant breakdown of the Born–Oppenheimer approximation. Zero field fine structure separations and level crossing magnetic fields have been calculated from the molecular parameters. They agree with previous experimental measurements but are considerably more extensive and more accurate. The radiative lifetime, as determined from the MOMRIE linewidth, is 29.4 ± 3.2 nsec. (auth)

16444 CALCULATION OF THE DYNAMIC POLARIZABILITY OF H_2 BY THE DISTINGUISHABLE ELECTRON METHOD. Venanzi, Thomas J.; Kirtman, Bernard (Department of Chemistry, University of California, Santa Barbara, California 93106). J. Chem. Phys. 58: No. 9, 3953-3958 (1 May 1973).

The first four Cauchy coefficients for H_2 are computed by the distinguishable electron method starting with the screened valence bond (Wang) initial approximation. In order to avoid the problem of evaluating two–center integrals with Slater–type orbitals of high principal quantum number, we use a set of fitted polarization functions determined by a minimum quadratic deviations procedure. Our Cauchy coefficients agree well with a previous accurate calculation by Victor et al., but are consistently smaller than the coupled Hartree–Fock values. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 16902, 16903, 16912, 16970, 16977, 16991, and 17032.

16445 POSITRON ANNIHILATION IN THE WIGNER CRYSTAL. Majumdar, Chanchal K. (Tata Institute of Fundamental Research, Bombay–5, India); Ramakrishnan, T. V. Phys. Rev. B 7: No. 5, 1850-1854 (1 Mar 1973).

The positron annihilation rate is calculated in the Wigner crystal and shown to approach the positronium value continuously from above as r_s becomes large. For $r_s \simeq 15$, the numerical value is roughly in agreement with what is expected from the knowledge of the rate in low–density metals. (auth)

16446 REALITY OF THE INNER STATE IN THE KAONIC ATOM. Atarashi, M.; Narumi, H. (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1427-1428(Oct 1972).

16447 FURTHER STUDY OF THE K^-–NUCLEUS OPTICAL POTENTIAL IN KAONIC ATOMS. Seki, Ryoichi (California State University, Northridge, California 91324); Kunselman, Raymond. Phys. Rev. C 7: No. 3, 1260-1262 (Mar 1973).

Using a local K^-–nucleus optical potential, we calculated x–ray energy–level shifts and widths and relative x–ray transition yields for kaonic atoms throughout the periodic table. We made a detailed study of the determination of the nuclear density parameters from level–shift and width data. (auth)

16448 $\alpha\,(Z\alpha)^2$ VACUUM–POLARIZATION CORRECTION IN MUONIC ATOMS. Bell, Thomas L. (The Enrico Fermi Institute, and the Department of Physics, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. A 7: No. 5, 1480-1488 (May 1973).

We use the Laplace transform obtained by Wichmann and Kroll for the vacuum–polarization charge density of order $(Z\alpha)^3$ induced by a point nucleus to determine the first few terms in the expansion of the charge density for small distances from the nucleus. The result is used to estimate the effect of the polarization charge near the nucleus on the muonic x–rays studied experimentally by Dixit et al. The effect is found to be somewhat smaller than an earlier estimate, and the discrepancy between theory and experiment is slightly reduced, but the discrepancy remains large for the high–Z muonic atoms, as much as three or four standard deviations in lead and barium. (auth)

Collision Phenomena

Refer also to abstracts 16425 and 16492.

16449 (LBL–1820) BEAM STUDY OF Ne^+ AND O_s^+ (^4S) SCATTERING BY MOLECULAR HYDROGEN ISOTOPES AND HELIUM. Winn, J. S. (California Univ., Berkeley, Lawrence Berkeley Lab). Jun 1973. Contract W-7405-eng-48. 360p. Dep. NTIS $20.00.

Thesis.

The velocity distributions of ionic products from Ne^+ and O^+ collisions with molecular hydrogen isotopes and with helium were measured. Reactive and nonreactive phemonema were investigated. Total and differential cross sections were found. Inelastic and dissociative features were found in these excitation processes. (JFP)

16450 AVERAGE ELECTRONIC FORM FACTORS FOR NEUTRAL ATOMS WITH $40 < Z < 90$. Bandopadhyay, P. K. (Univ. of Rhode Island, Kingston). J. Comput. Phys.; 12: No. 2, 280-284(Jun 1973).

Average electronic form factors were calculated using the Thomas–Fermi model, and an analytical fit to these form factors was obtained. This expression provides the average form factor as a function of $\lambda_Z^{\frac{1}{2}}$, a variable often used in connection with the Thomas–Fermi model. (JFP)

16451 RECENT THEORIES ON THE INTERACTION BETWEEN MOLECULAR BEAMS AND SURFACES. Nocilla, S. (Politecnico, Turin). Entropie; No. 49, 37-45(Jan 1973).

The most recent theories on the surface interaction between gas molecules and solids are presented. Particular attention is given to the following four points: the potential well adjacent to the solid surface and its physical effect on gas atom/solid atom pairwise Lennard Jones potentials; the roughness at the molecular level (used as a starting point for the development of all interaction theories) and the latest developments in impulsion models having aerospatial applications; theoretical explanation of the connection between unilobular and multilobular re–emission such as rainbow scattering. The usefulness of averaging and statistical procedures, and criticism of the reciprocity principle from both principal and mathematical considerations. (auth)

16452 LONG RANGE INTERACTION ENERGIES BETWEEN GROUND AND FIRST EXCITED STATE HYDROGEN ATOMS USING A ONE CENTRE METHOD. Bukta, J. F.; Meath, W. J. (Univ. of Western Ontario, London). Mol. Phys.; 25: No. 5, 1203-1205(May 1973).

A one center method is used to evaluate the long range interaction energies, through $O(R^{-10})$, where R is the distance between the interacting species, between ground and first excited state hydrogen atoms. General pseudo spectral results for both the direct and resonant parts of the expanded second and third order interaction energies are given through any order in R^{-1}. Of particular interest is an $O(R^{-9})$ third order energy which is totally resonant in character. The advantage of the one center method for interactions involving degenerate energy states is discussed briefly. (auth)

16453 EXPERIMENTAL APPARATUS FOR THE ANGULAR AND ENERGY DISTRIBUTION STUDY OF EJECTED ELECTRONS IN HEAVY PARTICLE COLLISIONS IN THE ENERGY RANGE 10 TO 150 keV. Benoit-Gattin, P.; Blanc, D.; Bordenave-Montesquieu, A.; Gleizes, A.; Rodiere, M.; Sobhanian, S. (Univ., Toulouse). J. Phys., E (London); 6: No. 6, 564-568(Jun 1973). (In French).

An experimental apparatus is described which allows the study of energy spectra of electrons ejected by direct ionization or via autoionization of helium atom. The target atom is excited by the impact of protons or hydrogen ions in the energy range 10 to 150 keV. Angular dependence of the peak shape obtained by decay in the continuum of autoionizing states of the helium atom is determined. As an example, preliminary experimental results obtained for 100 keV protons at 35° angle of ejection are given. Fano profile parameters q are extracted simultaneously for $2s^2\ ^1S$, $2p^2\ ^1D$ and $2s2p^1P$ structures by a computer fitting procedure. (auth)

16454 SCALING LAW FOR INNER-SHELL EXCITATION CROSS SECTIONS IN ION-ATOM COLLISIONS. Briggs, J. S. (Atomic Energy Research Establishment, Harwell, Eng.); Macek, J. H. J. Phys., B (London); 6: No. 6, 982-992(Jun 1973).

The conditions under which cross sections can be scaled from calculations on a one-electron system are investigated. The conditions are found to be met in the case of K-shell excitation in low-velocity symmetric ion-atom collisions. Cross sections for K-shell excitation in first row atoms are calculated in this way and are found to be in good agreement with existing measurements. (auth)

16455 COMPARISON OF BINARY-ENCOUNTER AND BORN APPROXIMATION FOR INCIDENT NEUTRAL SYSTEMS. Harberger, J. H.; Johnson, R. E.; Boring, J. W. (Univ. of Virginia, Charlottesville). J. Phys., B (London); 6: No. 6, 1040-1043(Jun 1973).

A comparison is made between "Born" and "binary-encounter" generalized oscillator strengths of the continuum states of hydrogen for hydrogen atom impact. The results of this comparison show that resonance excitations are less important for ionization by hydrogen atom impact than for ionization by proton impact and that, consequently, the Born and binary-encounter approximations will be in closer agreement in the former case than in the latter case. (auth)

16456 ROLE OF MANY-ELECTRON CORRELATIONS IN FAST ELECTRON ATOM INELASTIC COLLISIONS. Amusia, M. Y. (Physical Technical Inst., Leningrad); Cherepkov, N. A.; Sheftel, S. I.; Janev, R. K.; Zivanovic, D. J. Phys., B (London); 6: No. 6, 1028-1039(Jun 1973).

The effect of many-electron correlations in the inelastic electron-atom scattering at high energies is investigated. The importance of these correlations is shown by comparison of the results of calculations with the best possible independent particle model and the experimental data. Many-electron correlations are included in the random phase approximation with exchange and the corresponding integral equation for the effective interaction is displayed. This equation was solved numerically for argon, and generalized oscillator strength densities as well as the differential cross section were calculated. The results agree with the experiment quite well, showing thus the very important role the many-electron correlations play in the inelastic electron-atom scattering. The calculations confirm the relative importance of the monopole and the quadrupole transitions in the process under consideration. (auth)

16457 IMPULSIVE TRIDIMENSIONAL INTERACTION MODEL IN FREE MOLECULE FLOW. Chiadot-Piat, M. G.; Riganti, R. (Politecnico, Turin). Entropie; No. 49, 46-53(Jan 1973).

A spatial model for the interaction between a monoenergetic molecular beam and a rigid surface is presented. The unit fluxes into the incident plane and out of the incident plane are calculated for different angles of incidence and two values of the roughness parameter. The deviation of the specular reflection is calculated and qualitatively compared with theoretical and experimental results. (auth)

16458 ELECTRON DETACHMENT FROM NEGATIVE IONS BY CHARGED PARTICLE COLLISION. 1. Proton Impact. Gayet, R.; Janev, R. K.; Salin, A. (Bordeaux Univ., Talence, France). J. Phys., B (London); 6: No. 6, 993-1002(June 1973).

A theory is derived which accounts for the asymptotic effects of all Coulomb potentials occurring in the process of electron detachment from singly charged negative ions when colliding with charged particles. The T matrix element of this process is redefined in a way which makes initial and final channel states asymptotically identical to the outgoing and ingoing scattering wave functions respectively. Calculations of doubly differential, simply differential and total cross sections with proton impact are compared with the results given by the Born approximation. (auth)

16459 K-SHELL X-RAY EMISSION CROSS SECTIONS AND IONIZATION CROSS SECTIONS FOR LIGHT ATOMS AND MOLECULES BY H^+, H_2^+, AND He^+ IMPACT AT 30 TO 145 keV. Harrison, K. G.; Tawara, H.; de Heer, F. J. (FOM Institut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 66: No. 1, 16-32(15 May 1973).

The cross sections for K-shell X-ray emission were measured for 30 to 145 keV H^+, H_2^+ and He^+ ions incident on the gases CH_4, CO, N_2, Ne and Ar. Using values for the fluorescence yields derived from similar electron impact experiments, in which the same gas targets were used, the ionization cross sections for these K-shells by proton impact were deduced. The values thus obtained show reasonable agreement with the Auger-electron measurements of Stolterfoht for the gases CH_4 and N_2 in the energy range of overlap, 50 to 145 keV. For the lightest elements, C and N (in CH_4 and N_2), the K-shell ionization cross sections agree reasonably with the Born theory for ionization at the highest energies used. For Ne and Ar, with larger K-shell binding energies, and at low energies for C and N, the experimental cross sections are much smaller than the ones calculated by the Born approximation. These results are better described by the ionization theory of Brandt including Coulomb repulsion, binding and polarization effects, and the binary encounter theory of Garcia, which includes Coulomb repulsion effects. The contribution of electron-capture processes to the K-shell ionization cross sections is discussed. (auth)

16460 COLLISIONAL DETACHMENT FROM ATMOSPHERIC NEGATIVE IONS. Ranjan, R.; Goodyear, C. C. (Univ. of Liverpool). J. Phys., B (London); 6: No. 6, 1070-1078(Jun 1973).

Using a single-collision beam technique, cross sections were measured for the detachment of electrons from O^-, O_2^-, O_3^- and NO_2^- ions in oxygen, nitrogen and dry air, for NO_3^- in oxygen and nitrogen and for CO_3^- in oxygen. The ions were obtained from highly ozonized oxygen in an electron bombardment source and the ion energy range was from 20 to 100 eV. (auth)

16461 ELECTRON SCATTERING BY Li, Na, and K IN THE FROZEN CORE GLAUBER APPROXIMATION. Walters, H. R. J. (Queen's Univ., Belfast). J. Phys., B (London); 6: No. 6, 1003-1019(Jun 1973).

Cross sections for elastic scattering and excitation of the resonance transitions in Li, Na and K are calculated in the frozen core Glauber approximation. The total cross sections for the resonance transitions are observed to be in quite good accord with available experimental data. The importance of including the effect of the core electrons in the elastic scattering calculations is stressed. The first Born approximation for elastic scattering from Na and K is found to be in considerable error for the energy range studied (1 eV to 1 keV). "Theoretical" total cross sections calculated by adding experimental resonance cross sections to the Glauber elastic results agree reasonably well with experimental data. Glauber and first Born differential cross sections are also presented. (auth)

16462 ELECTRON CAPTURE FROM HYDROGEN AND HELIUM ATOMS BY FAST ALPHA PARTICLES. Belkic, D. S.; Janev, R. K. (Univ., Belgrade). J. Phys., B (London); 6: No. 6, 1020-1027(Jun 1973).

The continuum distorted wave method is applied to study electron capture collisions of fast alpha particles with hydrogen and helium atoms. The cross sections for capture into 1s, 2s, 2p, 3s and 3p final states are calculated in the energy range of 25 keV to 3 MeV. Necessary extensions of the method are done in order to treat capture to excited states. (auth)

16463 DW-VARIATIONAL STUDY OF COLLINEAR ATOM–DIATOM COLLISIONS. Koppel, Lewis M.; Lin, J. (Department of Chemistry, Boston College, Chestnut Hill, Massachusetts 02167). J. Chem. Phys. 58: No. 5, 1869-1876(1 Mar 1973).

Schwinger's variational principle in its fractional form is applied to the study of vibrational excitations in collinear atom-harmonic oscillator collisions. Trial wavefunctions used are those of distorted waves derived from distortion potentials based on (a) a free molecule approximation, (b) an internal average and (c) an optical potential recently proposed by Roberts. It is found that for nearest neighbor transitions in most of the systems studied a simple variational treatment yields transition probabilities superior to those of a perturbation expansion such as the distorted-wave Born series. (auth)

16464 POTENTIAL CURVES AND INELASTIC CROSS SECTIONS FOR LOW ENERGY COLLISIONS OF O^+ AND He. Augustin, S. D.; Miller, W. H. (Inorganic Materials Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720); Pearson, P. K.; Schaefer III, H. F. J. Chem. Phys. 58: No. 7, 2845-2850 (1 Apr 1973).

Potential curves corresponding to all the valence states of HeO^+ have been calculated with a minimum basis set and full configuration interaction. The principal inelastic process in low energy collisions of ground state He and O^+ is seen to be the ^4S–^2D excitation O^+, the transition arising from a spin–orbit interaction at a crossing of the lowest $^4\Sigma$ and $^2\Pi$ states of HeO^+. Much more accurate calculations were thus carried out for these two states, as well as a semiclassical calculation of the cross section for $He+O^+(^4S) \rightarrow He+O^+(^2D)$. The cross section has no activation energy other than its energetic threshold (3.3 eV) and rises to a maximum of $\sim 8.6\times10^{-3}$ Å^2 at $\sim$6 eV. There is a residual oscillatory structure in the energy dependence of the cross section, and it is shown how experimental observation of this could be used to obtain precise information concerning the relevant potential curves. (auth)

16465 SEMICLASSICAL TREATMENT OF RAINBOW MAXIMA IN DIFFERENTIAL CROSS SECTIONS FOR INELASTIC SCATTERING. Truhlar, Donald G. (Chemical Dynamics Laboratory,

Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). J. Chem. Phys. 58: No. 7, 3109-3109 (1 Apr 1973).

Previous results of Udseth et al. (J. Chem. Phys. 54, 3642 (1971)) on rainbow maxima in differential cross sections for elastic and inelastic scattering of H^+ by H_2 are summarized, and an attempt is made to explain the results using the distorted wave approximation in the semiclassical limit. Satisfactory agreement is obtained. (CES)

16466 CHARGE-CHANGING CROSS-SECTIONS AND PRE-EQUILIBRIUM CHARGE-STATE DISTRIBUTIONS OF ^{11}B RECOILS FROM $^{11}B(d,d)^{11}B$ ELASTIC SCATTERING. Mason, E. V. Jr. Pittsburgh; Univ. of Pittsburgh (1972). 49p. University Microfilms Order No. 73-13,185.

Thesis (Ph. D.).

Equilibrium and preequilibrium charge-state distributions were measured for ^{11}B recoils at 11.1×10^8 cm/s from $^{11}B(d,d)^{11}B$ elastic scattering in natural boron targets ranging in thickness from 0.03 to 54.20 $\mu g \cdot cm^{-2}$. No sudden change in the recoil charge-state distribution was observed for targets ≤ 0.20 $\mu g \cdot cm^{-2}$ in thickness. A coupled set of linear differential equations describing electron capture and loss was derived for recoiling ions from nuclear processes, and was used to calculate capture–loss cross sections from the ^{11}B recoil charge-state data and from two sets of recoil charge-state data which had been previously reported: charge-state distributions of ^{10}B recoils at 11.1×10^8 cm/s in graphite from the $^{12}C(d,\alpha)^{10}B$ reaction and charge-state distributions of ^{12}C recoils at 8.4×10^8 cm/s in graphite from $^{12}C(d,d)^{12}C$ elastic scattering. The calculated cross sections indicate that double electron capture or loss is not significant for the ^{11}B and the ^{12}C recoils in boron and graphite, respectively. A previously reported anomalous ^{10}B charge-state distribution from a 0.15 $\mu g \cdot cm^{-2}$ target was found to be inconsistent with the differential equations employed. (Diss. Abstr. Int., B)

16467 ATOMIC PHYSICS AND QUANTUM ELECTRODYNAMICS IN THE INFINITE MOMENTUM FRAME. Brodsky, S. J. (Stanford Univ., CA). pp 61-72 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The application of the infinite momentum method to quantum electrodynamics and the implementation of the renormalization procedure in perturbation theory are discussed. Several applications to problems in atomic physics are outlined. These are inelastic electron–atom scattering, high energy scattering, and rearrangement collisions in atom–atom scattering. (JFP)

16468 INNER-SHELL IONIZATION BY HEAVY CHARGED PARTICLES. Brandt, W. (New York Univ., NY). pp 155-168 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

K-shell ionization cross sections for projectile-target pairs $Z_1 \ll Z_2$ can be predicted comprehensively in terms of an approximate theory based only on the Coulomb excitation mechanism which includes effects caused by the finite charge of the moving point particle. By contrast when the projectile carries a coterie of electrons into the collision, inner-shell ionization occurs via complex many-body Pauli excitation processes. Pauli excitation cross sections can be larger by orders of magnitude than the Coulomb excitation cross sections, and depend in distinguishable ways on the projectile velocity. (auth)

16469 BOUND STATES AND CONTINUUM STATES OF ATOMIC SYSTEMS. Seaton, M. J. (University Coll., London). pp 205-219 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The properties of the solutions of the Schroedinger equation for a system containing N electrons and a nucleus of charge Z for fixed Z and N and different values of E are discussed. The bound states of neutral atoms and positive ions, the scattering of electrons by positive ions (excluding ionization) and especially electron–positive ion collisions are considered. Electron–helium ion and electron–neon ion collision and helium energy levels are included. (JFP)

16470 COMPLEX ROTATIONS IN ATOMIC SCATTERING THEORY. Doolen, G.; Hidalgo, M.; Nuttall, J.; Stagat, R. (Texas A and M Univ., College Station). pp 257-260 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

For the use of the theory of analytic functions of a complex variable to overcome some of the difficulties in calculating atomic scattering amplitudes, the complex rotation method in which all coordinates are transformed by $r_j \rightarrow r_j e^{i\alpha}$ is treated. (JFP)

16471 METASTABLE STATES OF HIGHLY EXCITED HEAVY IONS. Pegg, D. J. (Univ. of Tennessee, Knoxville); Griffin, P. M.; Sellin, I. A.; Smith, W. W.; Donnally, B. pp 327-337 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Autoionization electron spectra obtained using 2 and 6 MeV oxygen and fluorine ion beams on a carbon target are shown. The lifetimes of a nonradiative level in lithiumlike oxygen, fluorine, chlorine and argon are studied. Also the autoionization spectrum observed when 5-MeV chlorine ions are incident on a carbon target is shown. The main features of the presumed sodiumlike chlorine spectrum are shown. (JFP)

16472 DIFFERENTIAL CROSS SECTIONS FOR METASTABLE He AND Ar. Haberland, H.; Chen, C. H.; Lee, Y. T. (Univ. of Chicago). pp 339-352 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The experimental results and a preliminary analysis of the differential cross section for the systems He*–He, He*–Ar, and Ar*–Ar are presented, where * denotes the metastable state. (JFP)

16473 ROTATIONAL EXCITATION BY RESONANT TRANSFER OF ELECTRONIC EXCITATION. Flannery, M. R. (Georgia Inst. of Tech., Atlanta). pp 393-400 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

In order to examine resonant transfer, a semi-quantal theory was developed for the process $XY(i) + B(n) \rightarrow XY(j) + B(n)$ in which the electronic energy released (or absorbed) by a target atom B can be absorbed (or released) via a rotational or a vibrational transition in the molecule XY at thermal energies. Cross sections for hydrogen molecule collisions with hydrogen atoms are found as a function of impact energy. It is noted that the effect of these rotational transitions at thermal energies may possibly be significant in theoretical investigations of the interstellar medium. (JFP)

16474 ELECTRONIC POLARIZATION BEHAVIOR IN COLLISIONS. Bederson, B. (New York Univ., NY). pp 401-427 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

Electron–alkali element collisions at low energies where polarization effects appear are reviewed. The experimental aspects are primarily stressed, but the solution of the Schroedinger equation and close-coupling theory are also referred to. Elastic and total scattering in the alkalis, differential excitation cross sections for resonance transition, excitation and polarization of resonance radiation, excitation with spin-analysis differential spin-flip cross sections, and polarization effects in other types of atomic collisions are covered. (JFP)

16475 TEMPERATURE DEPENDENCE OF THE ELECTRON–RUBIDIUM SPIN-EXCHANGE CROSS SECTION. Davis, S. J.; Balling, L. C. (Univ. of New Hampshire, Durham). pp 463-469 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The line width and frequency shift of the spin resonance of electrons polarized by collisions with optically pumped Rb atoms were measured as a function of temperature from 200 to 840°K. (JFP)

16476 $e-0_2$ NS $e-H_2$ SCATTERING BY ELECTRON TIME-OF-FLIGHT SPECTROSCOPY. Land, J. E.; Raith, W. (Yale Univ., New Haven). pp 553-559 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

For electron–oxygen scattering the doublet structure of the resonances is shown. A fine structure splitting of $\Delta E = 20 \pm 2$ MeV is measured. It is found that the v = 3 vibrational level of O_2 at 570 MeV lies between the $v'' = 8$ doublet of O_2^-. Preliminary measurements of electron scattering of H_2 and D_2 between 20 and 100 MeV show that structure is present in the cross section. (JFP)

16477 SPIN POLARIZATION IN PROTON—XENON CHARGE EXCHANGE COLLISIONS. Macek, J.; Shakeshaft, R. (Univ. of Nebraska, Lincoln). pp 573-578 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

It is found that spin-polarized hydrogen atoms can be produced by charge transfer for H^+ in Xe. The occurrence of diffraction minima and maxima in the angular distribution of the scattered hydrogen atoms tends to increase the maximum value of the spin polarization. (JFP)

16478 COHERENT SCATTERING OF SOFT X-RAYS BY THE He-ATOM. Halpern, O.; Hall, H. Acta Phys. Austr.; 36: No. 2, 105-127(1972).

Continuing previously published investigations of the coherent scattering by a Dirac electron, the special case of the He-atom is studied. It is shown in detail that the case of He (and a few similar atoms) offers considerable analytical simplifications. The calculation is carried through with the aid of the method of variation of constants. An intellectual difficulty was encountered which one was unable to overcome; namely, the result differs from a previously obtained result by Furry who carried through his calculations with the aid of a rather complicated method used in the theory of radiative corrections. A detailed discussion of the possible reasons for this difference in the results is given. Assuming that all negative states are filled, scattering amplitude is obtained which differs from that of Waller. Attention is called to the reasonings about the summations to be carried out; the concept of a bound state in the screened field is essential. (auth)

16479 DIFFERENTIAL CROSS SECTION FOR ELASTIC SCATTERING OF ELECTRONS FROM ATOMIC HYDROGEN. Teubner, P. J. O.; Lloyd, C. R.; Weigold, E. (Flinders Univ. of South Australia, Bedford Park). J. Phys., B (London); 6: No. 6, L134-L137(Jun 1973).

The angular distribution for the elastic scattering of 50-eV electrons from atomic hydrogen was measured in the angular range 15 to 130°. The results are compared with those predicted by the Glauber approximation, the close coupling approximation, a multiple scattering approximation, the plane wave Born approximation, and a second order potential approximation. None of these approximations agree with the measured data over the whole angular range. (auth)

16480 ON THE ELECTRON BINDING ENERGY IN NEGATIVE IONS. Schmidt-Böcking, H.; Bethge, K. (II. Physikalisches Institut der Universität Heidelberg, D 69 Heidelberg, Germany). J. Chem. Phys. 58: No. 8, 3244-3247 (15 Apr 1973).

A new method has been developed to determine the electron binding energy in negative ions from charge exchange cross sections, which are proportional to the sum of the inverse binding energies. (auth)

16481 TOTAL ELECTRON IMPACT IONIZATION CROSS SECTION IN RUBIDIUM FROM THRESHOLD TO 250 EV. Nygaard, Kaare J.; Hahn, Yu Bong (Department of Physics, University of Missouri—Rolla, Rolla, Missouri 65401). J. Chem. Phys. 58: No. 8, 3493-3499 (15 Apr 1973).

A study of ionization in rubidium has been made in a crossed atom–electron beam apparatus. At an electron energy of about 10 eV there is a maximum in the cross section corresponding to the maximum probability for removal of the 5s valence electron. At 16.5 eV we have observed a new peak that is caused by the mechanism of autoionization. For energies below 30 eV there is a good agreement, both in shape and magnitude, between the present measurements and the empirical formula of Lotz. The over-all uncertainty in the measurements is $\pm 12\%$ which is mostly accounted for by the uncertainty in the determination of the rubidium number density. (auth)

16482 CHATTERING IN HARD SPHERE REACTIONS. Kendall, G. M. (Max-Planck-Institut fur Stromungsforschung, 34 Gottingen, Bottinger-Str. 6-8, Germany). J. Chem. Phys.; 58: No. 8, 3523-3524(15 Apr 1973).

It is pointed out that a previously proposed hard-sphere model (J. Chem. Phys. 49, 5046(1968)) of atom-diatom reactions which predicts many features of the $H + H_2$ reactions and its isotopic variants without using adjustable parameters neglects certain subsidiary collisions which may have significant effect at high energies. A complete analysis of the dynamics is shown to improve results in the systems $T + H_2$, $T + HD$, and $T + D_2$. (CES)

16483 FLUORESCENCE EFFICIENCIES OF NITROGEN AND AIR EXCITED BY NEON AND SODIUM IONS AT 0.3–2.0 MEV. Langley, Robert A. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Chem. Phys. 58: No. 9, 3675-3685 (1 May 1973).

The fluorescence efficiencies for excitation of nitrogen and air by neon and sodium ions have been measured at bombarding energies between 0.3 and 2.0 MeV. The molecular spectra studied were the first negative system of N_2^+ (1N) and the second positive system of N_2 (2P). The atomic spectra studied were the N^+ 5003 Å multiplet and the N^+ 5680 Å multiplet. The fluorescence efficiencies of the 3914 Å band and the 4278 Å band of the 1N system and the 3371 Å band of the 2P system were derived directly from the fluorescence data as were the efficiencies of the 5003 Å and 5680 Å multiplets. Efficiencies relative to the 3914 Å band were estimated for the ($v'=0, v''=0$–3)bands of the 1N system and the ($v'=0, v''=0$–5), ($v'=1$, $v''=0$–6), and ($v'=2$, $v''=2$–7) bands of the 2P system. In addition, collisional deactivation coefficients for the 5003 Å and 5680 Å multiplets were derived from the efficiency data. The efficiencies of all spectra studied increased with increasing energy, with the efficiency of the 3914 Å band being the largest (0.48%) at 2.0 MeV for Ne^+ in N_2. The ratio of the intensity of the 4278 Å band to that of the 3914 Å band indicates that the Franck–Condon principle is obeyed in this particular case. Also, the ranges of neon and sodium in nitrogen and air were obtained from emission measurements. (auth)

16484 COLLISION INDUCED DISSOCIATION: A STATISTICAL THEORY. Rebick, C.; Levine, R. D. (Department of Physical Chemistry, The Hebrew University, Jerusalem, Israel). J. Chem. Phys. 58: No. 9, 3942-3952 (1 May 1973).

A statistical theory of collision induced dissociation using the three body angular momentum introduced by Delves and Smith is presented. A distinction is made between direct dissociation (no two body intermediates) and indirect processes, due to the formation of quasibound diatoms (of either the chaperon or the energy transfer type). The post-threshold energy dependence in the statistical theory is of the type $A(E-E_0)^n/E_{tr}$ where E is the total energy and E_{tr} the translational energy. ($n \simeq 2$ or 1.5 for direct and indirect processes.) The threshold energy, E_0, can be determined by a suitably linearized plot without a prior determination of n. Following a series of diagnostic calculations for the reaction $He + H^+_2(v) \rightarrow He + H^+ + H$, the experimental results are simulated via the introduction of a nonstatistical (i.e., selective) bias by representing the dependence of A on the initial vibrational energy in the form $A \propto \exp(-\lambda_v f_v)$ where f_v is the fraction of energy in the vibration. (auth)

16485 CHARGE NEUTRALIZATION OF HE^+ ION BEAMS. Moran, T. F.; Conrads, R. J. (School of Chemistry, Georgia Institute of Technology, Atlanta, Georgia 30332). J. Chem. Phys. 58: No. 9, 3793-3799 (1 May 1973).

Total charge transfer cross sections for neutralization of He^+ ion beams have been measured for 1.0–3.0 keV ions. Time-of-flight methods have been used to identify the forward scattered He^0 products from He He^+ interactions with Ar, H_2, N_2, O_2, NO, CO, CO_2, CH_4, C_2H_4 and C_2H_6 targets. Both elastic and inelastic processes were included in the measurement of fast He^0 products. Total charge transfer cross sections are typically 5–15 $Å^2$ for most of the target gases with the exception of H_2 where cross sections are smaller. In the few cases where overlap exists, cross sections measured in the present investigation are in general agreement with previous measurements that have used apparatus designed to collect slow product ions with high efficiency. (auth)

Atomic Theory

Refer also to abstract 17113.

16486 RELATION BETWEEN UNCERTAINTY AND PERTURBATION THEORY. Tsapline, B. (Univ., Karlsruhe, Ger.). J. Phys., B (London); 6: No. 6, L131-L133(Jun 1973). (In French).

Integral functions and perturbation theory are used for estimating the magnitude of the Heisenberg uncertainty in simple atomic systems. (auth)

16487 HARTREE–FOCK EQUATION TAKING INTO ACCOUNT THE CORRELATION. Glembotskii, I. I.; Petkyavichyus, I. Yu. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; XIII: No. 1, 51-62(1973). (In Russian).

The question is considered of the extension of the Hartree–Fock equations with terms corresponding to the correlation. For this purpose the correlation pseudopotentials are used, which are obtained from the variational principle on the basis of the statistical theory of the atom. The Hartree–Fock equations completed in this way are solved for a series of atoms. The results are compared with the results obtained using ordinary Hartree–Fock wave functions as well as with the experimental data. (auth)

16488 THEORIES OF THE FINE STRUCTURE CONSTANT α. Adler, S. L. (Inst. for Advanced Study, Princeton, NJ). pp 73-84 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The theories for the fine structure constants α which are discussed are cosmological theories, microscopic theories relating α to the gravitational or weak interactions, theories in which α

is determined by electromagnetism alone, and numerological speculations using the Wyler formula. (JFP)

16489 EXOTIC ATOMS. Wu, C. S. (Columbia Univ., New York). pp 93-118 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The review of exotic atoms covers their formation, physical interest, and recent highlights including fundamental particle masses and magnetic moments, tests of vacuum polarization, resonance excitation by accidental degeneracy, and strong interactions and nuclear matter distributions. (JFP)

16490 STATISTICAL THEORY OF ATOM AND ION POLARIZABILITIES. Pustovalov, V. V.; Shevelko, V. P.; Vinogradov, A. V. (Lebedev Inst. of Physics, Moscow). pp 181-183 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The statistical Thomas–Fermi model of atomic structure is used to describe the existing experimental data on polarizabilities of atoms and ions with closed electronic shells. The aim was to obtain a theory without any approximations not connected with basic assumptions of the statistical model. (JFP)

16491 AB INITIO CALCULATIONS OF ATOMIC ENERGY SPECTRA. Jucys, A. P. (Inst. of Physics and Mathematics, Vilnius, Lithuanian USSR). pp 185-204 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The main features of ab initio calculations of atomic energy spectra are reviewed. Variational methods are emphasized. The use of nonorthogonal Hartree–Fock or analytical radial orbitals is indicated. Improved methods of atomic spectra theory are described, which are superposition of configurations, the extended method, and the method of incomplete separation of variables. (JFP)

16492 PROSPECTS: ATOMIC AND MOLECULAR PHYSICS. Amat, G.; Brossel, J.; Cohen-Tannoudji, C.; Ducuing, J.; Durup, J.; Feneuille, S.; Galatry, L.; Jacquinot, P.; Leach, S.; Schott, M.; Van Regemorter, H. Progr. Sci.; No. 161, 6-90(Feb 1973). (In French).

An extensive coverage is given of current problems in atomic and molecular physics, the electronic structure of atoms and molecules, the geometry, vibration, and rotation of molecules, the changes occurring in individual atoms and molecules, transient states in collision physics, and the effect of the environment on the changes occurring in atomic and molecular species. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

16493 UNSTEADY HYDROMAGNETIC BOUNDARY LAYER FLOW. Debnath, L. (East Carolina Univ., Greenville, NC). Tensor; 23: No. 3, 323-329(Dec 1972).

A generalization is made of Arora and Gupta's steady hydromagnetic boundary layer analysis. The unsteady hydromagnetic boundary layer flow in an electrically conducting fluid bounded by an infinite disk at z = 0, or by infinite parallel disks at z = 0 and z = h in the presence of a uniform magnetic field is considered. The solution for the velocity and the induced magnetic field is obtained for small and large times. It is shown that the velocity and the induced magnetic fields consist of both the steady and transient components. The skin friction, the rate of energy dissipation, current density, and the induced electric field are calculated. The findings of Arora and Gupta are recovered as special cases. (JFP)

16494 TRANSITION THROUGH THE INTERSECTION OF SEVERAL SHOCK SURFACES IN MAGNETOGASDYNAMICS. Sharma, V. D. (Banaras Hindu Univ., India). Tensor; 23: No. 3, 330-332 (Dec 1972).

The conclusion of Ram and Mishra, who obtained the necessary and sufficient condition for the transition of flow from state 1 to state 3 through the intersection of two successive shocks, is generalized for several successive shocks. (JFP)

16495 VORTICITY JUMP CONDITIONS ACROSS MAGNETOGASDYNAMIC DISCONTINUITIES IN PSEUDOSTATIONARY FLUID FLOWS. Murthy, D. N. (Nagarjunasagar Engineering Coll., Hyderabad, India). Tensor; 23: No. 3, 283-288(Dec 1972).

Assuming a moving surface of discontinuity and using the fundamental system of equations of a moving discontinuity in magnetic fluid dynamics in the streakline velocity vector field, the vorticity jump conditions across magnetogasdynamic discontinuities in pseudostationary fluid flows are established. (JFP)

16496 VORTICITY GENERATED BEHIND A TWO-DIMENSIONAL CURVED MAGNETOGASDYNAMIC SHOCK WAVE. Tembharey, D. J.; Sachdeva, S. K. (D. B. Science Coll., Gondia, India). Tensor; 23: No. 3, 289-292(Dec 1972).

It is shown that a formula for the vorticity jump across the shock wave can be directly derived from the momentum equation alone without actually evaluating the velocity gradient. Also the result is extended to the case of unsteady magnetogasdynamic shocks. (JFP)

16497 SIMILARITY SOLUTIONS FOR CYLINDRICAL BLAST WAVES IN MAGNETOGASDYNAMICS. Ray, G. Deb (Department of Mathematics, St. Xavier's College, Calcutta, India). Phys. Fluids 16: No. 4, 559-560 (Apr 1973).

Similarity solutions for strong cylindrical blast waves, under a constant axial current, and valid for small times, are obtained. The medium is of low constant pressure and follows an inverse power law for density. (auth)

16498 MAGNETOHYDRODYNAMIC STREAMING FLOW PAST A SPHERE AT LOW HARTMANN NUMBERS. Mathon, Rudolf (Department of Mathematics, University of Toronto, Toronto, 181 Canada); Ranger, K. B. Phys. Fluids 16: No. 4, 485-490 (Apr 1973).

The streaming flow of a weakly conducting viscous fluid past a nonconducting sphere in the presence of an aligned uniform magnetic field is investigated for low Hartmann numbers using a Galerkin method. If convection effects are neglected, it is found that eddies occur symmetrically fore and aft of the sphere when the Hartmann number exceeds 2.9. (auth)

16499 SOURCE FLOWS IN MAGNETOHYDRODYNAMICS. Yu, C. P.; Doe, A. L. (State University of New York at Buffalo, Buffalo, New York 14214). Phys. Fluids 16: No. 5, 696-698 (May 1973).

An analysis is presented for the magnetohydrodynamic flow due to a constant mass source expanding into a uniform magnetic field. The shape of the free surface is calculated as a function of time. The expansion of a plasma source into a vacuum in the presence of a magnetic field is of interest because of its applications to such problems as atmospheric explosion, exploding stars, etc. In this note, we consider a simple problem of the flow of a point mass source of constant strength in a uniform external magnetic field. We assume that the fluid is incompressible, inviscid, but with small finite electrical conductivity. Suppose that the source is turned on at a given initial time. We wish to determine the shape of the free surface of the fluid at any later moment. From the consideration of mass conservation, the velocity at any point will not vary with time after the fluid reaches there. We may, therefore, determine the velocity field from a steady flow problem. With this velocity field, the profile of the free surface can be obtained by integrating forward with time. (auth)

16500 MAGNETOHYDRODYNAMIC BOUNDARY LAYER CONTROL WITH SUCTION OR INJECTION. Wu, Yung-Kuang (MIT Lincoln Laboratory, Lexington, Massachusetts 02173). J. Appl. Phys. 44: No. 5, 2166-2171 (May 1973).

A steady two-dimensional magnetohydrodynamic boundary-layer control with uniform suction or injection is investigated. The transverse magnetic field is fixed to the semi-infinite flat plate and the electric field is assumed to be zero. A nonsimilar boundary-layer equation is solved numerically by a difference-differential method originated by Hartree and Womersley and improved by Katagiri. The velocity profiles and the coefficient of the skinfriction are computed for various values of magnetic parameter and suction/injection parameter. The graphical plots indicate increasing boundary-layer thickness and decreasing skin friction coefficient with increasing magnetic parameter, and also decreasing boundary-layer thickness and increasing skin-friction coefficient with increasing sunction/injection parameter. The magnetic field is found to be rather efficient in modifying the boundary layer, especially with the help of a proper seeding material. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 16576.

16501 (ITEF-858) SEARCHES FOR NEW QUASISTABLE ELEMENTARY PARTICLES BY DELAYED FISSION IN ^{197}Au TARGET IRRADIATED BY 6-GeV PROTONS. Kaftanov, V. S.; Trostin, I. S.; Shimkevich, A. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 12p. (In Russian). INIS.

An experimental search was instituted for hypothetical quasistable particles with a lifetime of $\geq 10^{-8}$ sec. Delayed fission in a ^{197}Au target caused by 6 GeV protons was studied. The search for rare fission events was conducted on a β, γ-background of activity. Schematic diagrams of the equipment are presented. Values of the upper limit of the cross section of formation of a pseudo-nucleus in the ^{197}Au target suggested a certainty of 90%. (tr-auth)

16502 ELEMENTARY PARTICLES AND THE FOUR FORCES OF NATURE. Jones, T. W. (University Coll., London). J. Inst. Nucl. Eng.; 14: No. 2, 35-38(Mar 1973).

From high energy research at CERN; London, Eng. (15 Jun 1972).

It is stated that, in spite of the apparent complexity of nature, physical phenomena can be described and sometimes quantitatively understood in terms of four basic forces or interactions. It may well be that further interactions will be discovered, particularly in phenomena that lie beyond present understanding, such as quasars and certain subnuclear phenomena, but this work is concerned with the properties of the so-called elementary particles and the four interactions influencing them, together with the experimental methods by which present understanding was obtained. Among matters discussed are: the need for high energy and the use of accelerators; detection techniques; recent equipment developments; the nature of an interaction; the gravitational force; weak interactions; electromagnetic forces; strong interactions; dynamical theories; and symmetries. (UK)

Electromagnetic

16503 (DNPL/R-24) SYNCHROTRON RADIATION: A BIBLIOGRAPHY. Marr, G. V.; Munro, I. H.; Sharp, J. C. C. (Daresbury Nuclear Physics Lab. (England)). 1972. 211p. Dep. NTIS (U. S. Sales Only) $12.75.

This bibliography reviews the whole field of synchrotron radiation including astrophysical applications and consists of over 700 references covering the period up to August 1972. It is arranged under the following headings: general articles and reviews; synchrotron radiation theory (general, polarization properties); synchrotron sources (machine physics, synchrotron radiation facilities); instrumentation (monochromators and other instruments, detectors, use as a standard source for calibration); experimental physics (atomic and molecular physics, solid state physics, x-ray diffraction, plasmas); astrophysics and synchrotron radiation (terrestrial sources, solar physics, general astrophysics). A full author index is included. (UK)

16504 (JINR-D-6840, pp 154-160) PRELIMINARY EXPERIMENTAL RESULTS OF A SEARCH FOR DIRAC MONOPOLES WITH THE 70 GeV PROTON SYNCHROTRON IFVE USING VAVILOV–CHERENKOV RADIATION. Zrelov, V. P.; Kollarova, L.; Kollar, D.; Yanik, R.; Lupil'tsev, V. P.; Pavlovich, P.; Sidorova, V. P.; Ruzhichka, Ya.; Shabatsov, M. F.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16505 SEARCH FOR THE RARE DECAY, $K^+ \rightarrow \pi^+e^+e^-$. Clarke, D. B. Madison, WI; Univ. of Wisconsin (1973). 104p. University Microfilms Order No. 73-2536.

Thesis (Ph.D.).

The decay, $K^+ \rightarrow \pi^+e^+e^-$, occurs at a branching ratio of less than 10^{-6}. The low branching ratio of this decay is taken as evidence that leptonic currents with zero total charge (neutral leptonic currents) are not present in the weak interaction Hamiltonian. This decay may occur by second order weak interaction at a low level, and is predicted to occur at a level of 10^{-6} to 10^{-7} by a combination of first order weak interaction and electromagnetic interaction. The results of a search for such decays conducted as a collaboration between the University of Wisconsin, the University of Hawaii, and Lawrence Berkeley Laboratory are presented. A large magnetic spectrometer using sparkostrictive wire chambers detected K^+ decays in a 1.475 GeV/c kaon beam at the Bevatron. Lepton pairs were identified by two large atmospheric pressure-Freon Cerenkov counters. Analysis programs identified events with three tracks or with two tracks which formed an e^+e^- pair. Analysis of the three track events yields the branching ratio limit, $[\Gamma(K^+ \rightarrow \pi^+e^+e^-)/\Gamma(K \rightarrow \text{all})] < 1.53 \times 10^{-6}$ (90% confidence). The two track events are analyzed by searching for sparks on possible pion track. The resulting limit, $[\Gamma(K^+ \rightarrow \pi^+e^+e^-)/\Gamma(K \rightarrow \text{all})] < 2.6 \times 10^{-7}$ (90% confidence), is lower than for three tracks because of increased triggering and program efficiencies. In the analysis, the invariant mass region, $Me^+e^- \leq 50$ MeV/c, is excluded to remove most of the background from Dalitz decays of a π^0 from other kaon decays. The Dalitz decays with $Me^+e^- > 50$ MeV/c, principally from $K_{\pi 2}$ decays, provide a calibration for the efficiency of the system. (Diss. Abstr. Int., B)

16506 REACTION $\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-p$ AT HIGH ENERGY AND PHOTON DISSOCIATION INTO FOUR PIONS. Davier, M.; Derado, I.; Fries, D. E. C.; Liu, F. F.; Mozley, R. F.; Odian, A.; Park, J.; Swanson, W. P.; Villa, F.; Yount, D. (Stanford Univ., CA). Nucl. Phys.; B58: No. 1, 31-44(1973).

The reaction $\gamma p \rightarrow \pi^+\pi^-\pi^+\pi^-p$ was studied using the SLAC 2-meter streamer chamber placed in an 18 GeV bremsstrahlung beam. Evidence was found for a broad enhancement (ρ') in the 4π mass spectrum at a mass of 1620 MeV with a width of about 300 MeV. This state is produced peripherally with a cross section consistent with being energy independent. I-spin = 1 (C = –1) is deduced from the dominant $\rho\pi\pi$ decay mode and $J \neq 0$ from the observation of a polarization phenomenon. Assuming quantum numbers $J^P = 1^-$, s-channel helicity is conserved at the γ–ρ' vertex. Further support for the J^P assignment is gathered when comparing the results to data from e^+e^- colliding-beam experiments. (auth)

16507 MULTIHADRONIC CROSS SECTIONS FROM e^+e^- ANNIHILATION UP TO 3 GeV CM ENERGY. Bacci, C. (Univ., Rome); Penso, G.; Salvini, G.; Stella, B.; Baldinicelio, R.; Capon, C.; Mencucuccini, C.;Muritas, G. P.; Spinetti, M.; Zallo, A. Phys. Lett.; 44B: No. 6, 533-536(11 Jun 1973).

With an apparatus slightly improved with respect to a previous one multihadronic production at the Adone e^+e^- storage ring up to a maximum center of mass energy of 3 GeV was studied. (auth)

16508 WIDE ANGLE ELECTRON–POSITRON BREMSSTRAHLUNG AT ADONE. A New Limit for the Existence of a Heavy Electron. Bacci, C. (Istituto Nazionale di Fisca Nucleare, Rome); Parisi, G.; Penso, G.; Salvini, G.; Stella, B.; Baldini Celio, R.; Capon, G.; Mencuccini, C.; Murtas, G. P.; Spinetti, M.; Zallo, A. Phys. Lett., B; 44B: No. 6, 530-532(11 June 1973).

The cross section for the reaction $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ was measured at the Adone storage ring. The results in agreement with the QED predictions, establish a new limit for the mass and the coupling constant $e^*e\gamma$ of a heavy electron e^*. (auth)

16509 LARGE-ANGLE HIGH-ENERGY PHOTOPRODUCTION OF SINGLE π^+ MESONS FROM LIQUID HYDROGEN. Anderson, R. L.; Gottschalk, B. ; Gustavson, D. B.; Ritson, D. M.; Weitsch, G. A. (Stanford University, Stanford, California 94305); (and others). Phys. Rev. Lett. 30: No. 13, 627-630 (26 Mar 1973).

We have measured angular distributions for single photoproduced π^+ mesons at 4.0–, 5.0–, and 7.5–GeV incident photon energies and at lab angles from 11° to 66° with the Stanford Linear Accelerator Center 8–GeV spectrometer. Combined with previous Stanford Linear Accelerator Center results, this gives complete angular coverages for this range of energies. The data show the usual "t" and "u" diffraction peaks and a "central plateau" region dropping as $S^{-7.3}$. (auth)

16510 STUDY OF SCALING IN THE INCLUSIVE ELECTROPRODUCTION REACTIONS $E^- + P \rightarrow E^- + \pi^\pm + X$. Bebek, C. J.; Brown, C. N.; Lichtenstein, C. A.; Herzlinger, M.; Pipkin, F. M.; (and others) (Cyclotron Laboratory, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. Lett. 30: No. 13, 624-626 (26 Mar 1973).

We report measurements of the inclusive electroproduction reactions $e^- + p \rightarrow e^- + \pi^\pm + X$. The measurements were made at two data points with the same value of the Bjorken scaling parameter, $\omega = 4.1$, and with Q^2 values of 1.20 and 2.02 GeV^2. The

virtual-photo-production cross sections are studied as a function of missing-mass variables and Feynman scaling variables. The results suggest a simple scaling behavior. (auth)

Weak

Refer also to abstract 16991.

16511 (CEA-N-1609) EXPERIMENTAL DETERMINATION OF THE PARAMETERS OF THE $K^+ \rightarrow \pi^+\pi^-e^+\nu$ DECAY. Zylbersteijn, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1973. 153p. (In French). Dep. NTIS (U. S. Sales Only) $9.75.

Thesis. Submitted to Paris Univ., Orsay (France).

An experiment utilizing electronic techniques enabled 1609 events occurring in $K^+ \rightarrow \pi^+\pi^-e^+\nu$ decay to be observed. The decay parameters were determined from an analysis of this experimental sample: form factors and phase shift differences encountered in the $\pi\pi$ scattering of (l = 0, I = 0) and (l = 1, I = 1) waves. The values obtained for the form factors are in perfect agreement with theoretical predictions. The phase shift difference was measured for three values of the equivalent mass of the two pions in the final state. Studies of the variation of this parameter with mass permitted the (l = 0, I = 0) scattering length to be determined. The value obtained exceeds the expected value by two standard deviations. (auth)

16512 (COO-2114-7) ELEMENTARY PARTICLE AND HIGH ENERGY PHENOMENA. Progress Report, September 1, 1972-September 1, 1973. Nauenberg, U.; Bartlett, D. (Colorado Univ., Boulder. Dept. of Physics and Astrophysics). 1973. Contract AT(11-1)-2114. 13p. Dep. NTIS $3.00.

Research on experimental weak and electromagnetic interactions is summarized. A list of publications is included. (JFP)

16513 (COO-3071-25) EARLY OBSERVATION OF NEUTRINO AND ANTINEUTRINO EVENTS AT HIGH ENERGIES. Benvenuti, A.; Cheng, D.; Cline, D.; Ford, W. T.; Imlay, R.; Ling, T. Y.; Mann, A. K.; Messing, F.; Pilcher, J.; Reeder, D. D.; Rubbia, C.; Sulak, L. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 16 Apr 1973. 8p. Dep. NTIS $3.00.

Preliminary results of two short runs with a broad band neutrino-antineutrino beam at NAL incident on about 120 tons of target which is part of a detector consisting of an ionization calorimeter and a muon magnetic spectrometer are presented. These results include the observed distribution in transverse muon momentum, dN/dp_μ, the average neutrino cross section at a mean neutrino energy of roughly 30 GeV, and the ratio of the antineutrino to the neutrino total cross section at a mean neutrino energy of 40 GeV. (auth)

16514 (ITEF-912) POSSIBILITY OF A DETECTION OF W-BOSON AND LEPTON PAIR PRODUCTION IN THE NEUTRINO BEAM OF A SERPUKHOV ACCELERATOR. Yield and Background Estimates. Kaftanov, V. S.; Kubantsev, M. A.; Khovanskii, V. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 971p. (In Russian). INIS.

The search for a W-boson and a muon pair with a spark detector in the neutron beam of a Serpukhov accelerator is described. The anticipated phonon reactions were calculated. The use of a spark detector at the IFVE accelerator made it possible to conduct a search for a W-boson up to a mass of ~6 GeV. An analogous analysis was made of the search for the direct production of a muon pair and various phonon processes. An increase in the number of neutrino events by a factor of 10 to 100 was essential for observing this reaction; this condition was realized through the introduction of a booster in the system. (tr-auth)

16515 (JINR-D-6840, pp 161-165) SEARCH FOR THE DECAY $K_s \rightarrow 2\gamma$. Barmin, V. V.; Barylov, V. G.; Dabidenko, G. V.; Demidov, V. S.; Dolgolenko, A. G.; Zombkovskaya, N. K.; Matveev, V. A.; Meshkovskii, A. G.; Mirosidi, G. S.; Novikov, L. S.; Chistyakova, T. A.; Chuvilo, I. V.; Shebanov, V. A.; Shishov, N. N. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16516 (JINR-D-6840, pp 166-174) STUDY OF K_1^0 REGENERATION, CARRIED OUT AT PHYSICS INSTITUTE, CZECHOSLOVAKIA ACADEMY OF SCIENCES. Votruba, Ya.; Gladki, Ya.; Novak, M.; Prokesh, A. (Inst. of Physics, Prague). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16517 (JINR-D-6840, pp 188-204) PHYSICAL AND CHEMICAL INVESTIGATION OF MESON POLARIZATION. Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16518 EXPERIMENTAL COMPARISON OF CP VIOLATION IN $\bar{K}^0 \rightarrow \pi^+\pi$ AND $K^0 \rightarrow \pi^+\pi$ DECAYS. Banner, D.; Frank, J.; Gormley, M.; Koester, L. J.; Raither, S.; (and others) (University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. D 7: No. 7, 1989-1999 (1 Apr 1973).

The time distributions of the decays $\bar{K}^0 \rightarrow \pi^+\pi$ and $\bar{K}^0 \rightarrow \pi^+\pi$ are directly compared in the same apparatus. K^0 ($\bar{K}^0$) mesons were produced by charge exchange of K^+ (K^-) in a carbon target. Wire spark chambers with magnetostrictive readout were used to detect the decays. The observation of the difference in the decay distributions of K^0 and $\bar{K}^0$ mesons serves as a direct proof, independent of any theoretical conventions, that CP is violated. No significant deviation from the presently accepted theoretical formalism of CP violation was found. The values of the CP-violating parameters for K^0 and $\bar{K}^0$ decays are compared. (auth)

16519 THREE-BODY DECAYS OF K^0 MESONS. Mallary, M. L.; Binnie, D. M.; Gallivan$, J. D.; Gomez, R.; Peck, C. W.; (and others) (California Institute of Technology, Pasadena, California 91109). Phys. Rev. D 7: No. 7, 1953-1970 (1 Apr 1973).

We have measured the time distributions of the $\pi^+e\bar{\nu}$, $\pi^-e^+\nu$, and $\pi^+\pi^-\pi^0$ modes from initially pure K^0's in a spark-chamber experiment performed at the Bevatron. From 1079 K_{e3} events between 0.2 and 7 K_S lifetimes, we find $ReX = -0.070 \pm 0.036$, $ImX = 0.107^{+0.092}_{0.074}$. This result is consistent with X=0 (relative probability=0.025). From 148 $K \rightarrow \pi^+\pi^-\pi^0$ events in the same fiducial volume we get $ReW = -0.05 \pm 0.17$ and $ImW = 0.39^{+0.35}_{0.37}$. ("W" is variously known as η^{+-0} and $x+iy$.) Our results are consistent with W=0 (relative probability=0.30). (auth)

16520 DECAY $K_L^0 \rightarrow \pi^\pm e^\mp \nu_e$. Albrow, M. G. (Univ. of Manchester, Eng.); Aston, D.; Barber, D. P.; Bird, L.; Ellison, R. J.; Halliwell, C. H.; Jones, R. E. H.; Kanaris, A. D.; Loebinger, F. K.; Murphy, P. G.; Strong, M. G.; Walter, J.; Yovanovich, D. D.; Templeman, R. F. Nucl. Phys.; B58: No. 1, 22-30(1973).

In a study of charged K_L^0 three-body decays a sample of 6,668 $K_L^0 \rightarrow \pi^\pm e^\mp \nu_e$ candidates has been obtained. The Dalitz plot distribution is in agreement with V-A theory, and limits are presented for scalar and tensor contributions to the weak current. Using a conventional expansion for the form factor $f_+\lambda_+ = 0.055 \pm 0.010$ is found with systematic effects estimated at ±0.01. (auth)

16521 STUDY OF DALITZ-PLOT DISTRIBUTIONS OF THE DECAYS $\eta \rightarrow \pi^+\pi^-\pi^0$ AND $\eta \rightarrow \pi^+\pi^-\gamma$. Layter, J. G.; Appel, J. A.; Kotlewski, A.; Lee, W.; Stein, S.; (and others) (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 7: No. 9, 2565-2568 (1 May 1973).

Based on 80884 events, we obtained the matrix element squared for the decay $\eta \rightarrow \pi^+\pi^-\pi^0$: $|M(x,y)|^2 = 1 - (1.08 \pm 0.014)y + (0.03 \pm 0.03)y^2 + (0.05 \pm 0.03)x^2$ where x and y are the usual Dalitz-plot coordinates. The γ-ray energy spectrum was measured for 18150 $\eta \rightarrow \pi^+\pi^-\gamma$ events. ρ dominance of the $\pi^+\pi^-$ final state is strongly favored over a simple gauge-invariant matrix element. (auth)

16522 RELATIVE DECAY RATES OF $\eta \rightarrow \pi^+\pi^-\pi^0$, $\eta \rightarrow \pi^+\pi^-\gamma$, $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$, AND $\eta \rightarrow \pi^+\pi^-$. Thaler, J. J.; Appel, J. A.; Kotlewski, A.; Layter, J. G.; Lee, W.; (and others) (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 7: No. 9, 2569-2571 (1 May 1973).

We have measured the branching ratio $(\eta \rightarrow \pi^+\pi^-\gamma)/(\eta \rightarrow \pi^+\pi^-\pi^0)$ to be 0.209 ± 0.004. The rare decays $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$ and $\eta \rightarrow \pi^+\pi^-$ were searched for and not found. The upper limit on the branching ratio $(\eta \rightarrow \pi^+\pi^-\pi^0\gamma)/(\eta \rightarrow \pi^+\pi^-\pi^0)$ is 0.0024 at 90% confidence level, and the upper limit on the width of the decay $\eta \rightarrow \pi^+\pi^-$ is 4 eV. We then have a limit on the rate of a P- and T-violating strong interaction: Rate (P- and T-violating strong interaction)/Rate (conventional strong interaction) $< 4 \times 10^{-3}$. (auth)

Strong (Baryon-induced)

Refer also to abstracts 16851 and 17057.

16523 (CERN/HERA-73-1) COMPILATION OF CROSS SECTIONS. III. p and $\bar{p}$ Induced reactions. Bracci, E.; Droulez, J. P.; Flaminio, E.; Hansen, J. D.; Morrison, D. R. O. (European Organization for Nuclear Research, Geneva (Switzerland)). 7 May 1973. 114p. Dep. NTIS (U. S. Sales Only) $7.75.

A compilation of cross sections of reactions produced by protons and antiprotons on targets of protons, neutrons and deuterons, is presented. This is an updated version of CERN/HERA 70-2 and 70-3 and contains 40% more data values than the earlier publications. It also contains some data from I.S.R., N.A.L. and Serpukhov up to Feb. 1973. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values of the rate of decrease of cross section with incident momentum are given. (auth)

16524 (COO-1545-127) HIGH ENERGY PHYSICS STUDIES. Progress Report Part I. Experimental Program. (Ohio State Univ., Columbus). 1973. Contract AT(11-1)-1545. 32p. Dep. NTIS $3.75.

Experimental research on strong interactions is summarized. A list of publications is included. (JFP)

16525 (FRNC-TH-290) DETERMINATION OF THE MULTIPLE SCATTERING OF PARTICLES HAVING TRAJECTORIES INCLINED IN RELATION TO THE PLANE OF THE EMULSION. Haudecoeur Meton, C. (Paris Univ. (France)). 1971. 79p. (In French). NTIS (U. S. Sales Only).

Thesis.

Antiproton-nucleus and antineutron-nucleus annihilation stars in nuclear emulsions were studied. A large number of particles are emitted at large inclination angles for incident particles having momenta of the order of a few GeV/c. An attempt was made to determine the value of $p\beta c$ for these particles. The results established by Apostolakis and Major in which it is demonstrated that most of the horizontal displacement of a point after treatment can be represented by a second degree polynomial and that the track is subsequently contained in a plane, are reconsidered. An attempt was made to establish a method of projection enabling the deformation undergone by the track in each plate traversed to be determined. In favorable cases it was possible to eliminate this deformation and thus determine the signal due to the multiple scattering only. This was accomplished in a systematic manner without the introduction of hypotheses concerning the nature of the deformation. A technique was used, which is dependent only on the track as it is observed in the emulsion. The track in the corresponding plate was not studied in doubtful cases. The method was successfully applied to particle tracks having a maximum $p\beta c$ value of the order of 150 MeV/c and whose inclination values can thus extend up to 70°. When larger $p\beta c$ values are considered, the multiple scattering is so small that there is a risk of its being eliminated in currently existing emulsions. (FR)

16526 (JINR-D-6840, pp 7-29) ELASTIC p-p, p-d, AND p-n SCATTERING AT SMALL ANGLES AT AN ENERGY INTERVAL OF 10 TO 70 GeV. Shafranova, M. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16527 (JINR-D-6840, pp 80-87) REACTIONS WITH DEUTERON BREAKUP IN dp INTERACTIONS AT 3.3 GeV/c IN A HYDROGEN CHAMBER. Glagolev, V. V.; Zelinski, P.; Lebedev, R. M.; Nassal'ski, Ya.; Nioradze, M. S.; Saitov, I. S.; Sandach, A.; Strel'tsov, V. N.; Stzpanyak, I.; Sharkhu, G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16528 (JINR-D-6840, pp 88-153) SEARCH AND INVESTIGATION OF MULTIBARYON NULL AND NONNULL RESONANCES WITH ZERO STRANGENESS. Shakhbazyan, B. A. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16529 (JINR-E1-7207) DEUTERON FORMFACTOR FROM EXPERIMENTAL DATA ON THE p-d ELASTIC SCATTERING AT SMALL ANGLES. Nikitin, V. A.; Shafranova, M. G.; Truong Bien, Zolin, L. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

The nuclear deuteron form factor was determined, using the Glauber model, from the experimental data on elastic scattering differential cross sections of protons on deuterons, protons on protons and neutrons on protons in the energy range of 10 to 26 GeV. Among the wave functions considered the Bressel-Kerman wave function is in the best agreement with experiment. The comparison of the p-d data shows that the distributions of nuclear matter and charge in the deuteron are equal within the errors. (auth)

16530 (LYCEN-7275) STUDY OF FINAL STATE INTERACTION IN THE P + D REACTION AND IN OTHER FEW NUCLEON REACTIONS. Chemarin, M. (Lyon Univ. (France). Institut de Physique Nucleaire). Dec 1972. 106p. (In French). Dep. NTIS (U. S. Sales Only) $7.50.

Thesis. Submitted to Lyon Univ. (France).

The break-up reaction for a deuteron was studied experimentally in the kinematic zones near to the final state (n-p) interaction (d + p at 27.5 MeV, p + d at 13.5 MeV). The results were compared with two simple models in which a description of the two-body aspect of the problem is emphasized: Watson-Migdal model; Phillips-Griffy-Biendenharn model. A more highly perfected tool was also used: the Amado model with Ebenhoch calculations: the three-body problem is correctly treated in the separable S wave approximation. In the other reactions studied(d + d, d + ^{3}He, d + ^{4}He, d + ^{6}Li at 27.5 MeV) the production of correlated (n-p) pairs was also studied in order to determine the importance of the final state interaction mechanism in the overall yield of the reaction leading to three particles in the exit channel. (auth)

16531 STUDY OF MULTIPARTICLE PRODUCTION IN pp AND pd INTERACTIONS NEAR 28 GeV/c. Hanlon, J. E. Nashville; Vanderbilt Univ. (1972). 113p. University Microfilms Order No. 73-14,508.

Thesis (Ph.D.).

The Brookhaven National Laboratory 80-inch bubble chamber was exposed to proton beams from the Alternating Gradient Synchrotron (AGS) to obtain data on the reactions $pp \rightarrow \pi^- +$ anything, (1), $pp \rightarrow \pi^- +$ anything, (2), $pp \rightarrow \pi^-\pi^- +$ anything, (3), $pp \rightarrow pp\pi^+\pi^-$, (4), and $pp \rightarrow pp\pi^+\pi^-\pi^+\pi^-$ (5) at 28.5 GeV/c; and $pd \rightarrow (p_s)pp\pi^-$ (6) and $pd \rightarrow (p_s)pp\pi^-\pi^-\pi^+$ (7) at 28.0 GeV/c. The inclusive pion spectra from reactions (1) and (2) are presented. A comparison of the target fragmentation spectra from reactions (1) and (2) with $\pi^\pm$p and K^+p bubble chamber data from other experiments supports the hypothesis that pion spectra from the reaction a + b → c + anything will approach a limiting distribution at relatively low incident energy when the quantum numbers of $ab\bar{c}$ are exotic in the SU(3) sense. However, the agreement of the π^+ spectra from the nonexotic reaction $\pi^-p \rightarrow \pi^+ +$ anything with the exotic spectra suggests this hypothesis may be irrelevant. Experimental distributions of azimuthal angles between pairs of particles produced in 28-GeV/c pp and pd collisions are presented and studied. Reactions (4), (5), (6), and (7) are studied as examples of one-, two-, three-, and four-pion production in 28 GeV/c proton-nucleon interactions. One- and two-pion production occurs mainly as the formation of a low mass proton-pion cluster opposite the remaining proton. This characteristic is seen to hold to a lesser degree for three- and four-pion production, although the data may be interpreted as showing that single cluster formation is still the dominant process. However, the reactions studied represent only the lowest multiplicities at 28 GeV/c and cannot be taken as a unique description of particle production at this energy. Correlations between $\pi^-\pi^-$ pairs produced in reaction (3) are studied in the high multiplicity final states containing six or more charged particles. It is seen that if the data for each multiplicity are examined separately the major portion of the data is consistent with uncorrelated π^- production. (Diss. Abstr. Int., B)

16532 DIFFRACTION SCATTERING OF DEUTERONS WITH 2.45 GeV/c MOMENTUM IN NUCLEAR PHOTOEMULSION. Karaba, J.; Karabova, M.; Tucek, J. (Univ., Kosice, Czech.). Fyz. Cas.; 22: No. 1-2, 77-87(1972).

Basic experimental data on the primary beam and cases of elastic scattering were obtained by measuring multiple scattering and ionization. After a correction for Coulomb scattering the cross section was obtained of the diffraction scattering of deuterons on the nuclei of photographic emulsion $\sigma_{el} = 792^{+93}_{-88}$ m barn. Reducing this value for 1 nucleon yields the value σ_{el}/nucl = 64 ± 7 m barn. The values of the differential cross sections obtained experimentally were compared with the square amplitude of diffraction scattering fd^2. A good agreement of the theoretical and experimental data can be seen in the region of very small angles. (auth)

16533 MEASUREMENT OF THE POLARIZATION PARAMETER IN π^-p ELASTIC SCATTERING AT 40 GeV/c. Bruneton, C. (Centre d'Etudes Nucleaires, Saclay, France); Bystricky, J.; Cozzika, G.; Deregel, J.; Derevschikov, A.; Ducros, Y.; Gaidot, A.; Kazarinov, Yu.; Kazarinov, M.; Kanavets, V.; Khatchaturov, B.; Lehar, F.; De Lesquen, A.; Matulenko, Yu.; Merlo, J. P.; Mecshanin, A.; Miyazhita, S.; Movchet, J.; Nurushev, S.; Pierrard, J.; Potashnikova, I.; Proskurin, G.; Van Rossum, L.; Saraykin, A.; Siksin, V.; Smirnov, E.; Solovyanov, V. Phys. Lett.; 44B: No. 5, 471-473(28 May 1973).

The first measurements of the polarization in the elastic scattering of negative pions from polarized protons at an incident pion momentum of 40 GeV/c is reported. The momentum-transfer region covered was $0.08 < |t| < 1.3$ $(GeV/c)^2$. The angular distribution of the polarization exhibits a first minimum of ~-6% and the well known zero around $t \approx -0.6$ $(GeV/c)^2$. The energy variation of the first minimum (at around $t = -0.2$) may be expressed in a simple form, $P_{avr} = -(0.48 \pm 0.06)\ s^{-0.52\pm0.05}$. (auth)

16534 REMARKS ON THE 200-GEV/C DATA AND THE INDEPENDENT-EMISSION MODEL. Thomas, G. H. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 7, 2058-2066 (1 Apr 1973).

A numerical analysis of pp→NNπ...π with an independent-emission

model is given at National Accelerator Laboratory energies and compared with a previous analysis at 21 GeV/c. Specifically, model calculations of distributions at 205 GeV/c and 21 GeV/c are presented, along with their implications for data. It is concluded that the most important feature left out of the model is the lack of two-or-more-particle interactions at the exclusive level. (auth)

16535 EVIDENCE FOR THE SYSTEMATIC BEHAVIOR OF CHARGED-PRONG MULTIPLICITY DISTRIBUTIONS IN HIGH-ENERGY PROTON-PROTON COLLISIONS. Slattery, P. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 7: No. 7, 2073-2079 (1 Apr 1973).

Evidence is presented to support the onset in the 50-303-GeV/c region of incident momentum of the asymptotic prediction of Koba, Nielsen, and Olesen regarding the scaling behavior of the charged-prong multiplicity distribution in proton-proton collisions. Lower-energy data, at 19 and 28.5 GeV/c, are found not to demonstrate this behavior. The impact of this observation on the Mueller-Regge viewpoint is discussed. (auth)

16536 CORRELATION BETWEEN THE PIONIZATION REGION AND THE FRAGMENTATION REGION IN HIGH ENERGY PROTON-PROTON COLLISIONS. Albrow, M. G.; Bagchus, A.; Barber, D. P.; Bogaerts, A.; Bosnjakovic, B.; Brooks, J. R.; Clegg, A. B.; Erne, F. C.; Gee, C. N. P.; Locke, D. H.; Loebinger, F. K.; Murphy, P. G.; Rudge, A.; Sens, J. C. (CERN, Geneva). Phys. Lett.; 44B: 518-520(11 Jun 1973).

Measurements are reported of two-particle correlations in high energy proton-proton collisions with one particle in the pionization region and the other a proton in the fragmentation region. The correlation function is independent of x of the fragmentation proton for $0.55 \lesssim x \lesssim 0.9$ and rises at small x. There is an indication that the correlation is an energy-independent function of x. The measurements for two values of the rapidity of the pionization particle give similar results. (auth)

16537 LARGE TRANSVERSE MOMENTUM PARTICLE PRODUCTION AT 90° IN PROTON-PROTON COLLISIONS AT THE ISR. Banner, M. (Centre d'Etudes Nucleares de Saclay, France);Hamel, J. L.; Pansart, J. P.; Stirling, A. V.; Teiger, J.; Zaccone, H.; Zsembery, J.; Bassompierre, G.; Croissiaux, M.; Gresser, J.; Morand, R.; Riedinger, M.; Schneegans, M. Phys. Lett.; 44B: No. 6, 537-540(11 Jun 1973).

Total charged particle fluxes above 1.2 GeV/c transverse momentum at 90° were measured at the CERN Intersecting Storage Rings for c.m. energies between 23.2 and 52.7 GeV. In addition, charged pion spectra above 3 GeV/c were obtained at 44.4 and 52.7 GeV, as well as gamma-ray spectra at the same energies. The upper limit to produce a single electron above 3 GeV/c at 90° is less than 1.2×10^{-33} cm^2/sr at 90% confidence level. (auth)

16538 PRODUCTION OF HIGH TRANSVERSE MOMENTUM PARTICLES IN p-p COLLISIONS IN THE CENTRAL REGION AT THE CERN ISR. CERN, Geneva. Phys. Lett., B; 44B: No. 6, 521-526(11 Jun 1973).

The inclusive production of all charged particles of transverse momentum p_T between 1.5 and 4.4 GeV/c at center of mass angles 90 and 59.4° from p-p-collisions with $\sqrt{s}$ = 44 and 53 GeV was measured. No strong energy dependence is observed for these transverse momenta. (auth)

16539 POWER-LAW ENERGY SPECTRUM DEDUCED FROM THE ANGULAR DISTRIBUTION OF NUCLEAR INTERACTIONS OF 20 TO $\sim 10^3$ GEV. Kim, C. O.; Sim, K. S. (Department of Physics, Korea University, Seoul, Korea). Phys. Rev. D 7: No. 9, 2597-2608 (1 May 1973).

The $\log_{10}F$ plots of the angular distribution for the forward-cone secondaries, observed in high-energy nuclear interactions produced in nuclear emulsion, are found to fit well to a linear function of η (θ) [$\simeq$0.46-ln tanθ], i.e., $\log_{10}F = \alpha\eta(\theta) + \gamma$. This fact is used to argue for the power-law differential energy spectrum in multiple production with the index of power α ln10, with the aid of already established experimental results. The values of α, obained from fitting procedures, are approximately equal to -1 for nuclear interactions with a sufficient number of charged secondaries in a wide range of the primary energy E_p between 20 and $\sim 10^3$ GeV. It is also concluded, from the systematic study of the 1335 30-GeV/c proton jets, that the nature of the target nucleus in the hadron-nucleus collisions does not affect the shape of the angular distribution of the forward-cone secondaries. (auth)

16540 STUDY OF THE INCLUSIVE REACTION P+P→P+X BETWEEN 40 AND 260 GEV/C USING AN INTERNAL H_2 JET TARGET. Sannes, F.; De Lillo, T.; Lieberman, M.; Mueller, J.; Robinson, B. (Rutgers University, New Brunswick, New Jersey, 08903); (and others). Phys. Rev. Lett. 30: No. 16, 766-769 (16 Apr 1973).

We have measured the relative energy dependence of the invariant cross section for the inclusive reaction p+p→p+X for $0.05 \leq M_X^2/s \leq 0.22$ at t=-0.033 and -0.045 GeV^2. The energy range from s=80 to 480 GeV^2 was covered continuously by taking data during the acceleration ramp of the National Accelerator Laboratory machine. The data are compared with the diffractive-excitation and Regge models. (auth)

Strong (Meson-induced)

16541 (COO-1428-321) ANNUAL PROGRESS REPORT, TASK A, FOR JUNE 1, 1972-MAY 31, 1973. Loeffler, F. J. (Purdue Univ., Lafayette, Ind.). 1973. Contract AT(11-1)-1428. 34p. Dep. NTIS $3.75.

Experimental research on strong interactions is summarized. A list of publications is included. (JFP)

16542 (COO-2232-7-Ex) MEASUREMENT OF PHOTOPRODUCTION OF ω^0 AND ρ^0 MESONS IN HYDROGEN. Gladding, G. E.; Russell, J. J.; Tannenbaum, M. J.; Weiss, J. M.; Thomson, G. B. (Harvard Univ., Cambridge, Mass.). 1972. Contract AT(30-1)-2752. 38p. (CONF-720923-14). Dep. NTIS $4.00.

From 16th international conference on high energy physics; Chicago, Illinois, USA (6 Sep 1972).

The t distribution for photoproduction of ρ^0 and ω^0 mesons from hydrogen was measured for incident energies between 2.0 and 4.7 GeV. A Söding interference model fits the ρ^0 data and gives t distributions in agreement with π^+p elastic scattering and most previous ρ^0 experiments; but disagrees with that of the SLAC, LBL laser beam bubble chamber. The ρ^0 decay density matrix shows nonconservation of s-channel helicity for $t \geq 0.5$ GeV^2. (auth)

16543 (IPNO/HE-73-2) MEASUREMENT OF THE POLARIZATION PARAMETER IN π^-p BACKWARD ELASTIC SCATTERING AT 6 GeV/c. Dick, L.; Janout, Z.; Aoi, H.; Caverzasio, C.; Gonidec, A.; Kuroda, K.; Michalowicz, A.; Poulet, M.; Sillou, D.; Aschman, D. G.; Booth, N. E.; Green, K.; Spencer, C. M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Feb 1973. 21p. Dep. NTIS (U. S. Sales Only) $3.25.

The polarization parameter in π^-p elastic scattering was measured in the backward angular region at an incident momentum of 6 GeV/c. The measurements cover the range of four-momentum transfer u = 0 to -1 (GeV/c)^2, and were obtained with a high intensity pion beam, a butanol polarized proton target, and arrays of scintillation counter hodoscopes. The polarization is different from zero, in contradiction to the prediction of the naive one trajectory Regge-exchange model. It increases positively with the four-momentum transfer u, reaching a maximum of about 0.4 at u approximately -0.3 (GeV/c)^2. It then decreases and becomes slightly negative beyond u approximately -0.5 (GeV/c)^2. This behavior is not predicted by any baryon exchange model. (France)

16544 (JINR-D-6840, pp 30-44) SINGLE AND DOUBLE DIFFERENTIAL CROSS SECTIONS IN π^-p INTERACTIONS AT 16 GeV/c. (Aachen-Berlin-Bonn-CERN-Krakow-Heidelberg Warsaw Collaboration). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The inclusive reactions $\pi^-p \to \pi^- + X^+, \to \pi^+ + X^-, \to p + X^-$ at 16 GeV/c in the variables missing mass squared and four-momentum transfer squared. An attempt was made to fit these distributions with some empirical exponential functions. The missing mass squared distributions of leading particles can be reasonably described by a sum of two exponentials. The corresponding distribution of produced π^+ mesons shows a simple exponential behavior for $M_X^2 > 9$ GeV^2. The $d\delta/dt$ spectra for all charged secondaries were fitted well with a sum of two exponentials. Using the variable $t' = |t - t_{min}|$ one gets a three step behavior of $d\delta/dt'$ for leading particles π^- and proton. The distribution of the π^+ mesons can be reasonably well described by a sum of two exponentials. As in exclusive reactions it is observed that the slopes of the differential cross sections decrease with increasing missing mass. This effect can be explained by the action of the centrifugal potential barrier. The predictions given previously by Muirhead do not agree with the experimental data. Refined calculations give an interaction radius depending on the inverse of the c.m. momentum of detected particle. Reasonable agreement with the data is obtained. (auth)

16545 (JINR-D-6840, pp 45-56) INTERACTIONS OF 40 GeV/c NEGATIVE PIONS IN THE TWO-METER PROPANE BUBBLE CHAMBER. (Bucharest-Budapest-Krakow-Dubna-Hanoi Serpukhov-Sofia-Tashkent-Tbilisi-Ulan-Bator-Warsaw Collaboration). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The review of π^- + p and π^- + n interactions at 40 GeV/c covers charged particle multiplicity distributions, neutral pion multiplicity, and scaling in π^- production. (JFP)

16546 (JINR-D-6840, pp 182-187) SEARCH FOR X^0 MESONS IN K^0_L DECAY. Votruba, Ya.; Gladki, Ya.; Novak, M.; Prokesh, A. (Inst. of Physics, Prague). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16547 (JINR-D-6840, pp 226-229) DETERMINATION OF MEAN EXCITATION POTENTIAL OF HYDROGEN. Hlavacova, J.; Patocka, J.; Michalcak, J. 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

Elastic scatterings of negative pions on protons at 5 GeV/c in a hydrogen bubble chamber were studied. A value of 13.9 eV was obtained as the mean excitation potential of hydrogen with standard deviation 0.8 eV. (JFP)

16548 (JINR-D-6840, pp 253-262) INVESTIGATION OF ENERGY FRAGMENTATION DISTRIBUTIONS. Biebl, K. J.; Gensch, U.; Schreiber, H. J. (Institut fuer Hochenergiephysik, Zeuthen, Ger.). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

Energy fragmentation distributions in inclusive reactions, $((E \pm p_L) \times d^3\delta/d^3p)$, and their momentum integrals yielding the energy fragmentation fractions of Chou and Yang are considered in 16-GeV/c π^-p interactions. (auth)

16549 (LBL-2017) PARTIAL WAVE ANALYSES OF $\pi^+p \to \pi^0\pi^+p$ AND $K^+\Sigma^+$ AT 1.28 TO 1.84 GeV/c. Kernan, A.; Fung, S. Y.; Mehtani, U.; Williamson, Y.; Michael, W.; Kalmus, G. E.; Birge, R. W. (California Univ., Berkeley. Lawrence Berkeley Lab). May 1973. Contract W-7405-eng-48. 6p. (CONF-730448-1). Dep. NTIS $3.00.

Partial wave analyses of $\pi^+p \to \pi^0\pi^+p$ and $K^+\Sigma^+$ have yielded values for the s-channel resonance parameters in the $\pi^0\Delta^{++}(1236)$ and $K^+\Sigma^+$ final states, and information on the t-channel exchanges leading to the ρ^+p final state. The analysis of $\pi^0\Delta^{++}$ (1236) also yields confirmation of a prediction, based on the duality hypothesis that the $\Delta(1236)$ will be in a pure helicity $\frac{3}{2}$ state. (auth)

16550 (UCR)-34-P-107-B-144) STUDY OF THE REACTION $\pi^+ + p \to \rho^+ + p$ AT INCIDENT MOMENTA 1.28 TO 1.84 GeV/c. Williamson, Y. S. (California Univ., Riverside). Dec 1972. 108p. Dep. NTIS $7.50.

The experimental results of a high statistics hydrogen bubble chamber study of the reaction $\pi^+ + p \to \rho^+ + p$ at seven values of incident pion momentum in the range 1.28 to 1.84 GeV/c. The principal features of the data are: The differential cross section, $d\sigma/dt$, is only a slowly varying function of the c.m. energy. At each momentum it has the strong forward peak and the dip at $-t \simeq 0.5$ GeV^2 which characterize this reaction at energies above the resonance region. There is a strong dip at $-t \simeq 0.4$ GeV^2 in both ρ^0_{00} and ρ^1_{00} $d\sigma/dt$. This dip has not been previously reported. It is predicted by the "strong cut Reggeized absorption" model (SCRAM), for absorbed pion exchange. SCRAM also predicts a zero in Re ρ^1_{10} at $-t \simeq 0.4$ GeV^2 associated with π exchange. In the momentum range 1.55 to 1.84 GeV/c, it is found that Re ρ^1_{10} passes through zero at $-t \sim .35 - .55$ GeV^2. The quantity $(\rho_{11} + \rho_{1-1})$ $d\sigma/dt$ has a pronounced dip at $-t \simeq 0.5$ GeV^2. This dip is observed at higher energies, and it is predicted for the ω exchange contribution to the cross section in either a conventional Regge pole model with nonsense wrong signature zeros or in a strong absorption model. In summary, the data show several structures which appear to be at fixed t. The nature of these structures suggests that the reaction $\pi^+p \to \rho^+p$ is dominated by π and ω exchange in the t-channel. The pronounced dip in ρ^1_{00} $d\sigma/dt$ and the zero in Re ρ^1_{10} further suggest that the π exchange is strongly absorbed. It is interesting that the dominance of t-channel exchanges found in the reaction $\pi^+ + p \to \rho^+ + p$ at higher energies persists all the way down to threshold. (auth)

16551 (UCR-34-P-107-B-162) DIFFRACTION DISSOCIATION IN π^-d INTERACTIONS AT 11.6 GeV/c. Oh, Y. T. (California Univ., Riverside). Jun 1973. 107p. Dep. NTIS $7.50.

Thesis.

The properties of diffraction dissociation were investigated from a study of π^-d interactions at 11.6 GeV/c. The baryon resonances N* (1500) and N* (1690) were produced from the dissociation of the target neutron. The assignments of spin $\frac{5}{2}$ and $\frac{5}{2}$ for N* (1500) and N* (1690) respectively were deduced from a study of the decay angular distributions. They were observed to have opposite parities from the interference effects. Identifying N* (1500) to be the $\frac{5}{2}^-$ nucleon resonance, the only known resonance in the mass region with isotopic spin of $\frac{1}{2}$, one was led to the spin-parity assignment of $\frac{5}{2}^+$ for N* (1690). The Gribov-Morrison hypothesis for pomeron coupling at the N*N vertex was hence confirmed. The t-channel helicity amplitude was found not to be conserved in the production process of $\pi^-n \to \pi^-N^*$. The N* 's were produced instead with a helicity of $\pm\frac{1}{2}$ in the t-channel. Cross section measurements indicate that approximately half of the N* (1690) enhancement seen in the missing mass experiment is due to $F_{15}(1690)$. The meson resonances A_1 and A_3 were produced via diffraction dissociation of the beam. Moments analysis of the decay correlations showed the spin-parity of A_1 and A_3 to be 1^- and 2^+ respectively consistent with the Gribov-Morrison rule. The t-channel helicity is conserved in the production process of A_1. There were also indications that the t-channel helicity was conserved in A_3 production. The $(d\pi^-)$ enhancement at 2200 MeV may be interpreted as the consequence of the Deck effect. The association of A_3 with the enhancement and duality arguments led to the interpretation that f-exchange is dominant in this production process. (auth)

16552 (UCR-34-P-107-B-164) ANNUAL REPORT. Kernan, A.; Poe, R. T. (California Univ., Riverside). May 1973. Contract AT(04-3)-34. 23p. Dep. NTIS $3.25.

Experimental research on strong interactions is summarized. A list of publications is included. (JFP)

16553 STRANGE PARTICLE PRODUCTION IN π^-p INTERACTIONS AT 2.1 GeV/c. Hoyer, G. A. Madison, WI; Univ. of Wisconsin (1972). 75p. University Microfilms Order No. 73-9201.

Thesis (Ph.D.).

Experimental results from π^- interactions in the Adair 14 inch liquid hydrogen bubble chamber at a pion momentum of 2.1 GeV/c are presented. These results are from the Σ^0K^0 final state and all final states in which a lambda hyperon is produced. Cross sections are reported for each of the final states studied. The cross sections for the Λ^0K^0 and Σ^0K^0 final states are compared with those obtained in other experiments as nearby beam momenta. The center of mass production angular distributions show the familiar tendency for the hyperon to go backward and the kaon to go forward. The two particle effective masses from the three body final states show evidence for the production of the K*(890) and the $Y^*_1(1385)$ resonant states, and possibly evidence for the N*(1860) resonant state. Cross sections for the production of the K* and Y^*_1 resonant states are estimated. The mean lifetime of the lambda hyperon and that of the K_s meson are measured. A variation of the measured mean lifetime with fiducial volume is reported. (Diss. Abstr. Int., B)

16554 TWO PI ZERO FINAL STATE IN PI PLUS DEUTERON INTERACTIONS AT 2.1 GeV/c. Braun, K. J. Madison, WI; Univ. of Wisconsin (1972). 126p. University Microfilms Order No. 73-2528.

Thesis (Ph.D.).

Using the reaction $\pi^+d \to pp(MM)$ at 2.13 GeV/c with photons from the final state π^0's detected by tantalum plates in the 30" ANL bubble chamber, a $2\pi^0$ mass spectrum was obtained in several ways. This spectrum is found to be in good agreement with phase space expectations and presents no evidence for the production of a "narrow" ϵ ($\Gamma < 200$ MeV). The $2\pi^0$ cross section for momentum transfers less than 15 μ^2 is 386 ± 30 μb. The $\pi\pi$ production and scattering angular distributions are presented. Good agreement with the OPE model is noted. Assuming that the ratios of peripheral pion production cross sections are equal to their pole values, a new method for extracting $\pi\pi$ scattering parameters is discussed. Using this method the I = 0 s-wave phase shift is uniquely determined from threshold to 1 GeV/c^2 and found to be similar to the so-called UP-DOWN solutions of s-p wave intereference analyses. In addition, near threshold the ratios of I = 0 to I = 2 s-wave scattering phase shifts and scattering lengths are found to be equal to $-(3.2^{+}_{-}{}^{5}_{0})$. Using a dispersion sum rule, the $\pi\pi$ scattering lengths are found to be $a_0 = +(0.15 \pm 0.08)\mu^{-1}$ and $a_2 = -(0.05 \pm 0.01)\mu^{-1}$. Finally, an $\eta'(958) \to$ neutrals cross section of 27 ± 13 μb is observed, and the $\eta' \to \gamma\gamma$ decay rate is found to be consistent with the currently quoted branching ratio of ~2%. (Diss. Abstr. Int., B)

16555 SEARCH FOR NEUTRAL STRANGENESS ONE BOSONS IN THE MASS REGION 500 TO 800 MeV. Hargis, P. J. Philadelphia; Univ. of Pennsylvania (1972). 178p. University Microfilms Order No. 73-13,412.

Thesis (Ph.D.).

The reaction $\pi^- + p \to \Lambda^0 + X^0$ was studied at twelve beams momenta between 0.998 and 1.468 GeV/c. The missing mass spectrum at each momentum was well fit by contributions from Λ^0K^0, Σ^0K^0, $\Lambda^0K^0\pi^0$, and $\Sigma^0K^0\pi^0$ production. The measured strange particle production cross sections are in good agreement with previous measurements. The upper limit to the production cross section for K* resonances was determined at the 95% confidence level as a function of mass and incident momentum. It was as-

sumed that such bosons have I = 1/2, full width $\Gamma \leq 16$ MeV, and are produced isotropically. If the production cross section is assumed constant over the momentum interval covered, the production cross section is less than 5 μb for decay to $K^0\gamma\gamma$ in the mass interval 512 to 640 MeV and for decay to $(K\pi)^0$ in the mass interval 640 to 800 MeV. For production with an $\exp(-8(t_0-t))$ angular distribution or an I = 3/2 boson the cross section limit for decay to $(K\pi)^0$ is 2.5 μb. (Diss. Abstr. Int., B)

16556 HIGH-ENERGY SCATTERING PROCESSES. Benecke, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Umschau; 71: No. 13, 478-480; 482-484(1971). (In German).

Particle production in $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ interactions is described. It is found that the inelastic effective cross section predominates, the mean particle number increases logarithmically with the primary energy, the effective cross sections are independent of energy, the secondary particle transverse distribution is independent of energy, and in elastic scattering the momentum distribution reaches a limit at high primary energy. (JFP)

16557 STUDY OF THE ρ (1710) AT 8.0 AND 18.5 GEV/C. Cason, N. M.; Biswas, N. N.; Kenney, V. P.; Madden, W. B.; Sander, O. R.; (and others) (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. D 7: No. 7, 1971-1977 (1 Apr 1973).

We have studied the reaction $\pi\, p \rightarrow p\rho$ (1710) $\rightarrow p\pi^+\pi\,\pi\,\pi^\circ$ at 8.0 and 18.5 GeV/c. Evidence is presented for the dominance of the $\rho\,\rho^\circ$ decay mode. An upper limit of 39% for $A\pi$ decay relative to all 4π decay modes, is determined for the ρ (1710). Assuming only $\rho\rho$ and $\omega\pi$ decay modes contribute, we find [ρ (1710) $\rightarrow \rho\rho$]/[ρ (1710) $\rightarrow$all 4π]=78$\pm$33) % and [ρ (1710) $\rightarrow \omega\pi$]/[ρ (1710) $\rightarrow$all 4π]=22$\pm$8) %. If the ρ (1710) is identical to the g(1680), we find $(g\rightarrow 2\pi)/(g\rightarrow 4\pi) = 0.35\pm 0.11$. The mass and width of the ρ (1710) determined from the (4π) mass spectrum are 1.687 ± 0.020 GeV and $0.169^{+.070}_{-.048}$ GeV, respectively. The production cross section is determined as a function of energy and, if a function of the form $\sigma = A_{lab}{}^n$ is assumed, we find $n = 1.4^{+0.5}_{-0.3}$. The distribution of four-momentum transfers, $t' = t - t_{min}$, for ρ (1710) production is characterized by a two-slope distribution with $\alpha_1 \simeq 9.6$ (GeV/c)^2 for $t' \lesssim 0.3$(GeV/c)^2 and $\alpha_2 \simeq 2.1$ (GeV/c)$^{-2}$ for $t' \lesssim 0.3$ (GeV/c)^2. (auth)

16558 PROPERTIES OF KK AND KKπ SYSTEMS AND DIFFRACTION DISSOCIATION. Diamond, R.; Lynch, J. T.; Peekna, A. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706); Binkley, M.; Walker, W. D.; (and others). Phys. Rev. D 7: No. 7, 1977-1985 (1 Apr 1973).

We present data on the KK system which is produced in the interaction of 7-GeV/c pions with nucleons. The neutral $K\bar{K}$ system is produced with a relatively large cross section, and the characteristics of the reaction seem consistent with one-pion exchange. The charged KK system is produced with a smaller cross section and is not dominated by one-pion exchange. The neutral $K\bar{K}$ system is dominated by an S-wave $K\bar{K}$ interaction up to a dikaon mass of about 1.3 GeV/c^2. If one examines the neutral KK system produced in conjunction with a π meson, the characteristics of the interaction seem to indicate diffraction dissociation as the production mechanism. The cross section for production of $\pi + (K\bar{K})^0$ is of the order of 150 μb. The system consisting of $\pi + (K\bar{K})^\pm$ is dominated by a K^+K^* amplitude. The cross section for the production of the π $(K\bar{K})^\pm$ system is four or five times smaller than for the π $(K\bar{K})^0$ system. Both the π $(K\bar{K})^0$ and the π $(KK)^\pm$ systems seem to be diffractively produced. (auth)

16559 OBSERVATION OF INTERFERENCE EFFECTS IN THE REACTION $\pi^+p \rightarrow \pi^+p\pi^0$. Michael, W. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 7: No. 7, 1985-1989 (1 Apr 1973).

In the reaction $\pi^+p \rightarrow \pi^+p\pi^0$ at 2.67 GeV/c, the central value of the ρ mass peak and its width are found to vary as a function of position in the Dalitz plot. The major variations are associated with the crossover regions of ρp with diffractively produced $\pi^+(p\pi^0)$ and π^+N^* final states, and so have a natural interpretation in terms of interferences among these final states. (auth)

16560 CHARGE TRANSFER IN K^-p INTERACTIONS AT 10 AND 16 GeV/c. Counihan, M. J. (CERN, Geneva). Nucl. Phys.; B58: No. 1, 325-332(1973).

A new type of variable is introduced for the analysis of strong interactions at high energies, namely the squared four-current transfer ("charge transfer") from the initial to the final state. Some interesting experimental results are found, and the value of this work as an approach to the problem of data presentation and interpretation for high-multiplicity reactions is emphasized. (auth)

16561 REACTIONS $K^-p \rightarrow \bar{K}^0n, K^-p \rightarrow \Lambda\pi^0$, AND $K^-p \rightarrow \Lambda\eta$ AT 3.13, 3.30, AND 3.59 GeV/c. Mason, G. C.; Wohl, C. G. (Oxford Univ.). Nucl. Phys.; B58: No. 1, 1-21(1973).

The differential cross sections for the reactions $K^-p \rightarrow \bar{K}^0n$, $K^-p \rightarrow \Lambda\pi^0$ and $K^-p \rightarrow \Lambda\eta$, and the Λ polarization distribution for the second reaction were measured at K^- lab momenta of 3.13, 3.30, and 3.59 GeV/c. The $K^-p \rightarrow \Lambda\pi^0$ polarization is very large: for the combined data in the interval $0.1 < -t < 0.4$ GeV^2, it is 0.98 ± 0.15. The $K^-p \rightarrow \Lambda\eta$ forward peak is very steep: for the combined data, the slope b in $d\sigma/dt = ae^{bt}$ is 16.2 ± 2.3 GeV^{-2}, whereas it is about 3 GeV^{-2} for $K^-p \rightarrow K^0n$ and 5 GeV^{-2} for $K^-p \rightarrow \Lambda\pi^0$. There is a dip near $t = -0.5$ GeV^2 in the $K^-p \rightarrow \Lambda\eta$ differential cross section, and another near $u = -0.3$ GeV^2 in the $K^-p \rightarrow \Lambda\pi^0$ differential cross section. The results are compared with predictions of simple models. (auth)

16562 PRODUCTION OF THE $K\pi\pi$ SYSTEM IN K^+n AND K^+p INTERACTIONS AT 4.6 GeV/c. De Jongh, G. (ULB-VUB, Brussels); Tavernier, S.; Cornet, P.; Dufour, P.; Grard, F.; Windmolders, R.; Charriere, G.; Dunwoodie, W.; Grant, A., Goldschmidt-Clermont, Y. Nucl. Phys.; B58: No. 1, 110-139 (1973).

In an experiment with the CERN 2 m deuterium bubble chamber, the $(K\pi\pi)^+_0$ systems in the effective-mass range below 1.5 GeV are studied for the reactions (1) $K^+n \rightarrow K^+\pi^+\pi^-n$, (2) $K^+n \rightarrow K^+\pi^-\pi^0p$, (3) $K^+n \rightarrow K^0\pi^+\pi^-p$, (4) $K^+p \rightarrow K^+\pi^+\pi^-p$, at 4.6 GeV/c incident momentum. Cross-section values are presented and the general features of these reactions are described. In addition the $(K\pi\pi)^+$ production and decay properties are investigated for reaction (1) and (4), and the results compared with the corresponding results for charge-exchange production of the $(K\pi\pi)^0$ system for reactions (2) and (3). (auth)

16563 INCLUSIVE REACTIONS $K^-p \rightarrow \bar{K}^0 + X^0$ AND $K^-p \rightarrow K^{*-}(890) + X^+$ AT 8.25 GeV/c. Athens-Democritus-Liverpool-Vienna Collaboration. Nucl. Phys.; B58: No. 1, 178-194(1973).

The inclusive reactions $K^-p \rightarrow \bar{K}^0 + X^0$ and $K^-p \rightarrow K^{*-}(890) + X^+$ are studied in detail at 8.25 GeV/c. The most prominent experimental features are discussed in connection with a triple-Regge behavior and, where relevant, compared with the corresponding data of K^+p at the same energy. Evidence for pseudoscalar exchange dominance at small t' and low missing mass is suggested by the density matrix element analysis of $K^{*-}(890)$. The natural- and unnatural-parity contributions to the cross section in the helicity frame indicate characteristics of absorptive behavior. (auth)

16564 CHARGED PARTICLE MULTIPLICITY DISTRIBUTIONS FOR 33.8 GeV/c K^-p AND 50 GeV/c π^-p INTERACTIONS. France-Soviet Union and CERN-Soviet Union Collaborations Nucl. Phys.; B58: No. 1, 77-92(1973).

Topological cross sections and average charge multiplicities $\langle n_c \rangle$ are presented for 33.8 GeV/c K^-p and 50 GeV/c π^-p interactions observed in the 4.5 m Mirabelle hydrogen bubble chamber at Serpukhov. Values for $\langle n_c \rangle$ of 5.16 ± 0.08 and 5.71 ± 0.13 were found for the K^-p and π^-p reactions, respectively. The two quantities $\langle n_c \rangle$ and the correlation term f_2 have been tabulated for $\pi^\pm p$, $K^\pm p$, and pp reactions at various energies. It is shown that the energy variation of each of these two quantities is described by a universal curve when plotted against the Q-value of the reaction. The ratio $\langle n_c \rangle / D$, where D is the dispersion of the multiplicity distribution, is found to approach the constant value of 2 from above as the energy increases. (auth)

16565 REACTION $K^-p \rightarrow \Lambda\eta$ FROM 0.80 TO 1.84 GeV/c. Rader, R. (Centre d'Etudes Nucleaires, Saclay, France); Barloutaud, R.; Griselin, J.; Prevost, J.; Tallini, B.; Filthuth, H.; Leibscher, R.; Schleich, H.; Meyer, J.; Petersen, J.; Smith, J. R.; Vrana, J. Nuovo Cim.; 16A: No. 1, 178-186(1 Jul 1973).

New data are presented on the reaction $K^-p \rightarrow \Lambda\eta$ from 0.80 to 1.84 GeV/c. An interpretation is attempted in terms of the formation of known hyperon resonances. (auth)

16566 K^+-NEUTRON ELASTIC DIFFERENTIAL CROSS SECTION NEAR 180° FOR INCIDENT KAON MOMENTUM BETWEEN (1.0-1.5) GeV/c. Carter, R. S. Jr. Seattle; Univ. of Washington (1973). 176p. University Microfilms Order No. 73-13,802.

Thesis (Ph. D.).

The elastic differential cross section for K^+n scattering near 180° was measured. The incident kaon momentum was varied in 50 MeV/c steps between 1.0 and 1.5 GeV/c. A series of counters, magnetostrictive wire spark chambers, and an on-line computer were used to detect and record each event. The K^+n differential cross section is found to vary as $s^{-2.3}$ with a value of 250 μb/sr at 1.0 GeV/c. The shape of the cross section indicates that there is Reggeized baryon exchange in the backward direction, while the magnitude of the cross section shows that exchange degeneracy between the α and γ Regge trajectories is broken. There is evidence of structure in the cross section near 1.2 GeV/c suggesting, but not proving, the existence of the Z* resonance. (Diss. Abstr. Int., B)

16567 MEASUREMENT OF NEUTRAL CASCADE PRODUCTION FROM NEGATIVE-KAON-HYDROGEN AT 1.8 GEV/C, $K^-P \to K^0\Xi^0$. Carlson, James R.; Davis, Howard F.; Jauch, Delbert E. (Department of Physics, Oregon State University, Corvallis, Oregon 97331); Sossong, Norman D.; Ellsworth, Robert. Phys. Rev. D 7: No. 9, 2533-2537 (1 May 1973).

The reaction $K^-p \to K^0\Xi^0$ was investigated in a counter-spark-chamber experiment carried out at the Bevatron. The c.m. angular distribution was obtained from a sample of 59 events for an incident meson momentum of 1.8 GeV/c. A Legendre-polynomial fit to the data yielded the coefficients $B_0=1.00\pm0.27$, $B_1=0.45\pm0.42$, $B_2=1.08\pm0.47$, $B_3=-1.20\pm0.62$ for an expression of the form $d\sigma/d\Omega=(\sigma/4\pi)\sum_{l=1}^{l=4}B_lP_l(\theta)$, where σ=total cross section, and θ=c.m. production angle of the K^0, $P_l(\theta)$ = lth Legendre polymonial. The χ^2 for this three-degree-of-freedom fit was 3.00. (auth)

16568 REACTIONS $K^-D \to \bar{K}^0\pi^-D$ AND $K^-D \to \bar{K}^0\pi^-NP_S$ AT 5.5 GEV/C. Johnson, D.; Cho, Y.; Derrick, M.; Musgrave, B.; Wangler, T. (Argonne National Laboratory, Argonne, Illinois 60439); (and others). Phys. Rev. D 7: No. 9, 2537-2553 (1 May 1973).

New data are presented on cross sections and angular distributions of resonances produced in the reactions $K^-d \to \bar{K}^0\pi^-d$ and $K^-d \to \bar{K}^0\pi^-np$, at 5.5 GeV/c. The production mechanisms and decay angular distributions are analyzed for the K^* (890), $\bar{K}^*$ (1420), and Δ (1236) resonances. The $\bar{K}^0\pi^-np$, final state is discussed in terms of the Veneziano B_5 model and also using the Van Hove longitudinal-phase-space technique. In addition, a Regge model with absorption is used to describe Δ (1236) production in the reaction $\bar{K}N \to K\Delta$ (1236). The spherical harmonic moments of the $\bar{K}^0\pi^-$ system as a function of $K\pi$ mass are discussed for the reaction $K^-d \to \bar{K}^0\pi^-p+MM$. (auth)

16569 HIGH-ENERGY π-π COLLISIONS. Robertson, W. J.; Walker, W. D. (Department of Physics, Duke University, Durham, North Carolina 27706); Davis, J. L. Phys. Rev. D 7: No. 9, 2554-2564 (1 May 1973).

We have examined the final states $\pi^-+\pi^++n$, $\pi^-+\pi^-+\Delta^{++}$, and $\pi^-+\pi^0+\pi^-+\pi^++p$ resulting from the interactions of 25-GeV/c π^- mesons incident on the BNL 80-in. Hydrogen Bubble Chamber to study elastic and inelastic π-π scattering processes. Using the Dürr-Pilkuhn parametrization for off-mass-shell corrections we determine the $\pi^-\pi^+$ and $\pi^-\pi^-$ cross sections. The elastic cross sections decrease with increasing dipion energy to a value of 1.5-2.0 mb. From the optical theorem it is found that the total cross sections become about 15 mb in the 2-4-GeV/c^2 region. We have also looked at the properties of the reaction $\pi^-+\pi^0 \to \pi^-+\pi^0+\pi^-+\pi^+$. The g meson seems to be prominently produced in this reaction. Angular correlations found at lower energies are also observed. (auth)

16570 ANTIPROTON-PROTON ANNIHILATION INTO CHARGED PION AND KAON PAIRS FROM 0.7 TO 2.4 GEV/C. Nicholson, H.; Barish, B. C.; Pine, J.; Tollestrup, A. V.; Yoh, J. K. (California Institute of Technology, Pasadena, California 91109); (and others). Phys. Rev. D 7: No. 9, 2572-2590 (1 May 1973).

A counter-spark-chamber experiment has been performed to measure the annihilation reactions $\bar{p}p \to \pi^+\pi^-$ and $\bar{p}p \to K^+K^-$ in the energy region 0.7-2.4 GeV/c. The angular region covered in the experiment was $0.65 \leq |\cos\theta_{c.m.}| \leq 1.0$. The data were taken in order to study heavy bosons (mass greater than two nucleons) that might couple to the $\bar{p}p$ system. Our data have been combined with data from a previous BNL-Caltech experiment to give complete folded angular distributions and total cross sections for these reactions at 12 incident momenta. The folded two-pion annihilation data have been fitted by a simple Breit-Wigner resonance model in order to explore possible resonance behavior. The extreme-angle data have been interpreted in terms of particle exchanges and, through crossing symmetry comparisons are made with backward πp and Kp scattering. (auth)

Particle Interactions and Properties (Theoretical)

16571 ALL PHOTOPRODUCTION POLARIZATION THEOREMS. Harunar Rashid, A. M. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 15A: No. 4, 713-722(21 Jun 1973).

A simple derivation of Stichel and Ravndal theorems in photoproduction with polarized photons is given for all spin-J boson exchanges. Using Moravcsik amplitudes in photoproduction, it is then shown that Stichel-type theorems can be written down easily for all photoproduction observables. (auth)

General

Refer also to abstracts 16502, 17271, 17295, and 17306.

16572 (BNL-tr-542) MODERN ELEMENTARY PARTICLE PHYSICS AND DEVELOPMENT OF NEW ACCELERATORS. Blokhintsev, D. I.; Efremov, A. V.; Muradyan, R. M. Translated by S. J. Amoretty (Brookhaven National Lab.) from Usp. Fiz. Nauk; 109: No. 2, 259-268(1973). 21p. Dep. NTIS $3.25.

Existing and planned accelerators are discussed. Also considered are elementary particle physics problems including elementary length, hypothetical particles, strong, electromagnetic, and weak interactions. (JFP)

16573 (COO-1428-320) ANNUAL PROGRESS REPORT, TASK B, FOR JUNE 1, 1972-MAY 31, 1973. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 1973. Contract AT(11-1)-1428. 25p. Dep. NTIS $3.25.

Research in theoretical high energy physics is summarized. A list of publications is included. (JFP)

16574 (COO-3130-TA-288) PROGRESS REPORT FOR A RESEARCH PROGRAM IN THEORETICAL HIGH-ENERGY PHYSICS. Feldman, D. (Brown Univ., Providence, R. I. Dept. of Physics). 1 Jun 1973. Contract AT(11-1)-3130. 10p. Dep. NTIS $3.00.

Research in theoretical high energy physics is summarized. A list of publications is included. (JFP)

16575 (IFVE-STF-72-1) PRODUCTION OF PARTICLES WITH FINITE MOMENTA AT HIGH ENERGIES, AND THE PIONIZATION PHENOMENON. Ezhela, V. V.; Logunov, A. A.; Mestvirishvili, M. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 12p. (In Russian). INIS.

A new characteristic of multiplicity, convenient for describing the production of particles with finite momenta is described. An analogous concept might be introduced for the diffraction region. On the basis of the analytics of inelastic amplitudes according to angular variables in the vicinity of physical points, it was shown that for the existence of the phenomenon of pionization, it was essential that the average multiplicity $\langle\eta_0\eta_d\rangle_v$ grow rapidly with an increase in energy, and that the differential cross section of the inclusive process, at large angles, decrease with increase in energy not more rapidly than 1/S. If only one of these conditions is unfulfilled, the phenomenon of pionization will not occur. (tr-auth)

16576 (JINR-D-6840) PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON HIGH ENERGY AND ELEMENTARY PARTICLE PHYSICS. Symposium Held in Strbske Pleso, CSSR, October 3-9, 1972. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1973. 398p. (In Russian and English). (CONF-721090--).

The 33 papers included in the proceedings are abstracted or title listed individually in NSA. (JFP)

For abstracts of individual papers see: 15628, 15629, 16504, 16515-16517, 16526-16528, 16544-16548, 16591, 16592, 16650-16652, 16671, 16717, 16718-16724, 16747-16749, 16794, and 16845.

16577 (ORO-3992-133) PROGRESS REPORT ON RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY, 1972-1973. Sudarshan, E. C. G.; Ne'eman, Y. (Texas Univ., Austin. Center for Particle Theory). 1973. Contract AT(40-1)-3992. 78p. (CPT-182; AEC-133). Dep. NTIS $6.00.

Research in theoretical high energy physics is summarized including field theoretic models, strong interaction phenomenology, algebraic approaches, and weak and electromagnetic interactions. A list of abstracts of publications is included. (JFP)

16578 NEW DUAL MODELS OF CURRENTS. Tze, Hsiung Chia (The Enrico Fermi Institute and the Department of Physics, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 7: No. 6, 1675-1696 (15 Mar 1973).

Through a real and a complex linear combination of two conformal scalar fields, we obtain the rubber-band field of the Virasoro-Shapiro model (VSM) and a complex field suited for dual current models. A Möbius-invariant pionic off-shell extension of the VSM is then presented. For $k^2_i=1$, it has conformal invariance, and the associated sets of gauge as well as supergauge identities are shown to be operative For other specific values of k^2_i, the new amplitude gives a correct continuation away from $k^2_i=1$. By combined use of the complex field and the Sakita-Gervais fields, we construct SU(1,1) and/or conformal-invariant spinor generalizations of the Rebbi-Drummond model. Their analytic structure is studied. In the particular case of the simple quark model with unitary spin of Bardakci and Halpern, we find two conformal-invariant conserved vector currents. One of these is akin to an axial-vector current as it exhibits a dual analog of partial conservation of axial-vector current. (auth)

16579 ANALYTICITY AND DUAL ABSORPTIVE MODELS. Fleming, H. (Univ., Sao Paulo, Brazil). Rev. Brasil. Fis.; 1: No. 2, 303-309(Oct 1971).

Realizations of the dual absorptive model of Harari by the sum

of a Regge recurrence in the direct channel are discussed and in particular a construction proposed by Ingraham is criticized in the light of some general properties of Regge trajectories that follow from analyticity. (auth)

16580 NEW FORM OF DYNAMICS AND CURRENT ALGEBRA. Hsu, J. P. (Department of Physics, Rutgers State University, New Brunswick, New Jersey 08903). Ann. Phys. (N.Y.) 75: No. 2, 479-490 (Feb 1973).

We study a new form of dynamical system, in which the commutation relations for the dynamical variables of a quantized field are defined on a "lightlike surface" $\pi \equiv (t+z)/\sqrt{2}=0$ rather than at one instant of time $t=0$. We clarify the physical implications of the use of the new variables $x^1=x$, $x^2=y$, $x^+=(t+z)/\sqrt{2}$, $x^-=(t-z)/\sqrt{2}$ and explore its significance as a new form of relativistic dynamics, which holds in any Lorentz frame but not in the so-called "infinite momentum frame." Using the quark model, we build up a new algebra of currents, in which the current commutators are defined at equal τ. The sum rules and other results of the usual current algebra can be obtained without taking the unjustifiable limit of infinite momentum. In particular, we obtained the Gell-Mann-Okubo mass formulas in quadratic form for both mesons and baryons without the trouble due to momentum dependence. We derive the reduction formula and find the physical high energy limit (not the Bjorken limit) of an amplitude is determined by the equal π commutator. (auth)

16581 NUMERICAL EVALUATION OF PHASE-SPACE INTEGRALS AND THEIR APPROACH TO ASYMPTOTIC BEHAVIOR. Chen, Min-Shih; Peierls, Ronald F. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 7: No. 7, 2183-2189 (1 Apr 1973).

We examine the range of validity of various approximate expressions for invariant phase space and "transverse-cutoff" phase space by checking against Monte Carlo calculations. We find that there are discrepancies for the transverse-cutoff case in the transition energy region between the isotropic and one-dimensional regimes. Since the location of this transition region is multiplicity-dependent, there are observable consequences for energy dependence of multiplicity distributions. (auth)

16582 STABILITY OF PROTONS AND ELECTRONS AND LIMITS ON TACHYON MASSES. Murthy, P. V. Ramana (Tata Institute of Fundamental Research, Bombay 5, India). Phys. Rev. D 7: No. 7, 2252-2253 (1 Apr 1973).

Danburg and Kalbfleisch interpreted the absence of observable proton decays in their recent experiment in terms of a very small value for the coupling constant mediating the decay of a proton into itself and a tachyon. In drawing this conclusion, the authors had to assume that the imaginary mass of neutral tachyons is $\gtrsim$100 MeV which was a limitation set by their experimental conditions. We point out other experimental evidence that can be used to limit the imaginary mass of neutral tachyons to values $\gtrsim 10^4$eV. (auth)

16583 DESCRIPTION OF AN UNSTABLE SYSTEM. Havlicek, M.; Exner, P. (Charles Univ., Prague). Czech. J. Phys.; B23: No. 6, 594-600(1973).

The paper collects some general properties of the description of an unstable particle considered by Horwitz and Marchand. It is proved generally that the initial decay rate of finite energy states equals zero. (auth)

16584 OFF-MASS SHELL PHYSICAL STATE PROJECTION OPERATOR FOR THE DUAL RESONANCE MODEL. Corrigan, E. F.; Goddard, P. (Univ. of Durham, UK). Phys. Lett.; 4B: No. 6, 502-506(11 Jun 1973).

Extending recent work of Brink and Olive, an off-mass shell physical state projection operator for the critical dimension, $d = 26$, of space-time, for the conventional dual resonance model is constructed. It can be used to give a direct calculation of the single planar dual loop amplitude, and to express amplitudes entirely in terms of physical state creation operators. (auth)

16585 NEW EFFECTS IN THE ISR REGION. Casher, A.; Nussinov, S.; Susskind, L. (Tel-Aviv Univ., Israel). Phys. Lett.; 44B: No. 6, 511-514(11 Jun 1973).

It is suggested that the increase of total cross sections and large P_T effects observed over the ISR range have a common origin in the hard collision of parton pairs. The observed magnitude of these effects suggest a parton-parton cross section ~0.2 mb. The data are consistent with vector gluon exchange mechanisms. These mechanisms can also cause inhibited shrinkage and energy dependent dips in differential cross sections. (auth)

16586 SINGLE PARTICLE DISTRIBUTIONS FROM VENEZIANO AMPLITUDES. I. Biebl, K. J.; Bebel, D.; Ebert, D. (Deutsche Akademie der Wissenschaften, Berlin). Fortschr. Phys.; 20: No. 9, 541-554(1972).

The single particle distribution for the inclusive reaction A + B → C + anything is calculated from the discontinuity of the Veneziano six point function in the tree approximation and investigated in different kinematical regions. Power series expansions around $x = 1$ and Barnes-Mellin integral representations suitable for expansions around $x = 0$ are presented. For large transverse momenta the single particle distribution shows an exponential decrease in $p_\perp^2$ with an x dependent slope assuming the value $4\alpha'$ for $x = 0$. For small transverse momenta the behavior of the distribution function in the pionization region is determined by a logarithmic singularity at the unphysical point $p_\perp^2 = -m_c^2$. In addition single particle distributions following from two special types of Pomeron-background modified B_6 functions are studied. Most of the results are similar to those obtained with the unmodified B_6 function. This applies in particular to the pionization region, where the asymptotic p^2-slope $4\alpha'$ is replaced by a "background slope" $4\beta'$. (auth)

16587 INCOHERENT MULTIPLE-SCATTERING EFFECTS IN THE PRODUCTION OF PARTICLES ON NUCLEAR TARGETS. Trefil, J. S. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901); von Hippel, Frank. Phys. Rev. D 7: No. 7, 2000-2012 (1 Apr 1973).

We discuss, using the Glauber multiple-scattering formalism, the magnitude of the contributions to particle production cross sections from nuclei at high energies which can be attributed to multiple-inelastic scattering processes involving a number of nucleons. Of particular interest is the contribution of such processes to the production of particles with high spin or hypercharge, since the beam particle can be "promoted" to these final states as a result of series of collisions, each involving only a relatively small change in its spin or hyperchange. When we compare these "promotional" production cross sections due to multiple scattering within a nucleus with estimates of the corresponding production cross sections due to multiple scattering within a single nucleon target. The basic reason seems to be that the "thickness" of nuclear matter offered to a beam particle passing through the center of an individual nucleon is not so much smaller in units of mean free paths than that offered by a nucleus. (auth)

16588 UNSTABLE PARTICLE SCATTERING IN THE LSZ FORMALISM. Liu, Tsu-huei (Department of Physics, Portland State University, Portland, Oregon); Zimmerman, Robert L. J. Math. Phys. (N.Y.) 14: No. 5, 666-675 (May 1973).

The properties of the unstable particles are studied by investigating the Lee model and a modified form of it. We define the unstable particle to be the complex pole of the analytically continued Green's function on the unphysical Riemann sheet. The mass and lifetime of the unstable particles are determined. Different ways of calculating the renormalization constant are discussed. The Lehmann-Symanzik-Zimmermam (LSZ) formalism is extended to include the unstable particles. Decay and scattering amplitudes for the unstable particles are calculated. The formalism is exact and does not depend on the arbitrary separation of the total Hamiltonian. Comparison with results obtained by other methods is discussed. (auth)

Electromagnetic

Refer also to abstracts 16225, 16226, 16240, 16902, 16903, 17078, 17291, 17292, 17308, and 17311.

16589 (COO-1764-179) FORMULATION OF BETHE-SALPETER EQUATION IN e-p DEEP INELASTIC SCATTERING. Lau, W. Y. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1972. Contract AT(11-1)-1764. 37p. Dep. NTIS $4.00.

Using perturbation theory for a model of pseudoscalar (neutral) mesons coupled with the proton, the hadronic part of an amplitude is calculated for a set of dominant ladder diagrams in e-p deep inelastic scattering. A Bethe-Salpeter equation type of formalism is set up and it is found, in the Bjorken limit and for large ω, that the structure function νW_2 is nonscaling, supporting a previous calculation by Chang-Fishbane. On the other hand, it is also found that, by introducing a lower bound x_{min} in the integral representation of the amplitude, the scaling property of νW_2 can be revived to the same form as that obtained by Drell et al. who use a cut-off assumption for the transverse momentum of the mesons. (auth)

16590 (ITEF-920) ALIGNMENT OF PAIR ANGLE DISTRIBUTIONS BETWEEN GAMMA QUANTUMS AT THREE QUANTUM RADIATIVE DECAY BY THE PEARSON CURVES. Guter, R. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1972. 15p. (In Russian). INIS.

The possibility of utilizing the Pearson distribution curves for describing the first type of electrical distributions or of distributions obtained by model simulation, of angles between pairs of gamma quanta during three-quanta radiation decay was examined for the scheme $X \rightarrow Y + \gamma \rightarrow 3\gamma$. The best results for approxima-

tion accuracy were obtained for the distribution of the largest angles. (tr-auth)

16591 (JINR-D-6840, pp 362-367) MINIMALLY NONLOCAL ELECTROMAGNETIC INTERACTIONS. Petras, M. (Comenius Univ., Bratislava). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

It is shown that besides the previous methods there exists a new one based on a special kind of nonlocality called the minimal nonlocality in quantum electrodynamics. (JFP)

16592 (JINR-D-6840, pp 368-385) PROTON ELECTROMAGNETIC STRUCTURE. Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16593 (JINR-P2-7096) POSSIBILITY OF MEASURING THE ELECTROMAGNETIC FORM FACTORS $F_\pi(m^2)$ AND $F_1^V(m^2)$ IN REACTIONS OF THE $\pi^- + p \to e^+ + e^- + n$ TYPE. Baldin, A. M.; Suleimanov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 23p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.25.

The possibility of measuring the electromagnetic form factors $F_\pi(m^2)$ and $F_1^V(m^2)$ in a timelike region of m^2 from $\pi^- + p \to e^+ + e^- + n$-like experiments is studied. These experiments permit one to investigate the indicated form factors at the values of m^2 not observed in colliding beam experiments. $F_\pi(m^2)$ and $F_1^V(m^2)$ are the only free parameters in the model, proposed earlier, that describes the reaction $\pi^- + p \to \gamma_V^* + n$ in terms of elementary pion and nucleon exchanges in t- and s-channels, respectively. Here γ_V^* is an isovector virtual photon. It is possible to select the combinations of the density matrix elements p_{ij} (i, j = 0, ± 1) for the reaction $\pi^- + p \to \gamma_V^* + n$ that will depend, to a high accuracy, on $F_\pi(m^2)$ and $F_1^V(m^2)$. Their experimental study would give some information about $F_\pi(m^2)$ and $F_1^V(m^2)$. The situation gets complicated for the values of m^2 inside a ρ resonance region due to $\rho^\circ - \omega -$ interference effects. As shown it is possible to obtain $F_\pi(m^2)$ analyzing one reaction, namely $\pi^- + p \to e^+ + e^- + n$. Whereas in order to obtain a mean value of F_1^V in the resonance region, it is necessary to investigate the reactions $\pi^- + p \to e^+ + e^- + n$ and $\pi^+ + n \to e^+ + e^- + p$ simultaneously. (auth)

16594 (RL-73-12) MAGNETIC MOMENT OF THE Δ^{++} IN A BOOTSTRAP MODEL. Chao, Y. A.; Zia, R. K. P. (Rutherford High Energy Lab., Chilton (England)). Apr 1973. 9p. Dep. NTIS (U. S. Sales Only) $3.00.

The magnetic moment of Δ^{++} is calculated in a bootstrap model with neutron exchange. Its value turns out to be significantly different from the quark model prediction. (auth)

16595 CLASSICAL RADIATION OF ACCELERATED ELECTRONS. II. A QUANTUM VIEWPOINT. Schwinger, Julian (University of California, Los Angeles, California 90024). Phys. Rev. D 7: No. 6, 1696-1701 (15 Mar 1973).

The known classical radiation spectrum of a high-energy charged particle in a homogeneous magnetic field is rederived. The method applies, and illuminates, an exact (to order α) expression for the inverse propagation function of a spinless particle in a homogeneous field. An erratum list for paper I is appended. (auth)

16596 APPROXIMATE SOLUTIONS OF PREDICTIVE RELATIVISTIC MECHANICS FOR THE ELECTROMAGNETIC INTERACTION. Bel, L.; Salas, A.; Sánchez, J. M. (Universidad Autónoma de Madrid, Departamento de Física, Canto Blanco. Madrid-34, Spain). Phys. Rev. D 7: No. 4, 1099-1106 (15 Feb 1973).

We solve the equations of predictive relativistic mechanics for the electromagnetic interaction of two structureless point charges, up to second order in the coupling constant $g=e_1e_2$, using as a subsidiary condition the Liénard-Wiechert formulas, for both the advanced and the retarded potentials, separately or in the time-reversal-invariant combination. Our general results reduce in the case of one-dimensional rectilinear motion to those obtained previously by Hill, which, as shown recently by Andersen and von Baeyer, are reliable in the low-energy regime. In the time-reversal-invariant combination, if $g<0$, concentric circular motion is possible; and assuming that both charges have equal masses we compare the speed-vs-radius relation obtained in this theory to that obtained in the Breit-Darwin approximation and in Wheeler-Feynman electrodynamics. (auth)

16597 FINITE MASS SPLITTING OF THE NUCLEONS. Duncan, Anthony; Schattner, Peter (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 6, 1861-1870 (15 Mar 1973).

We calculate the neutron-proton mass difference in second order in a simple semirealistic gauge model of the weak and electromagnetic interactions. The mass splitting is finite. It is found that in the limit of infinitely heavy gauge mesons, the mass difference becomes the divergent one of conventional quantum electrodynamics. In the course of the calculation, certain general features of such models, which might be relevant for analogous calculations with more complicated groups, will be exhibited. (auth)

16598 VENEZIANO-TYPE $NN\pi$ FORM FACTOR AND THE GOLDBERGER-TREIMAN RELATION. Dominguez, C. A. (Departamento de Fisica, Centro de Investigación y de Estudios Avanzados del, Instituto Politécnico Nacional, Apartado Postal 14-740, Mexico 14, D.F.). Phys. Rev. D 7: No. 4, 1252-1253 (15 Feb 1973).

It is shown that by means of a Veneziano representation of the $NN\pi$ form factor it is possible to explain around 40% of the corrections to the Goldberger-Treiman relation. (auth)

16599 SCALING IN A GLUON MODEL IN THREE DIMENSIONS. Bitar, Khalil M. (The Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 4, 1184-1196 (15 Feb 1973).

We study the scaling behavior of the structure functions of both deep-inelastic electron-proton scattering and inclusive electron-positron pair annihilation into a proton in a simple gluon model in three dimensions. We find first that both sets of structure functions have similar scaling properties, as expected on the basis of light-cone dominance, and that they are simply related to one another. Secondly, we obtain nonvanishing longitudinal structure functions in spite of the underlying bilinear fermion structure of the current. This confirms a positivity constraint discussed earlier and implies that interactions alter the free light-cone commutator structure. Thirdly, the transverse functions increase linearly with large ω again confirming the results of our earlier paper. (auth)

16600 CURRENT ALGEBRA IN THE DUAL PARTON MODEL. Brower, R. C.; Susskind, L. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 4, 1032-1037 (15 Feb 1973).

The assumptions of current algebra and partial conservation of axial-vector current are reformulated in the idealized dual-resonance model as assumptions about the flow of quantum numbers on the two-dimensional world sheet. The usual current-algebra results are recovered as projections of the two-dimensional current algebra into the four-dimensional world. Throughout we use the Kraemmer-Nielsen-Susskind interpretation of the world sheet. (auth)

16601 UNIFIED GAUGE THEORIES OF HADRONS AND LEPTONS. Bars, I.; Halpern, M. B.; Yoshimura, M. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 7: No. 4, 1233-1251 (15 Feb 1973).

If we insist on $SU(3) \times SU(3)$ classification for hadrons, in the presence of the known low-lying multiplets, we are led to models of the following nature: Before spontaneous breakdown, we have two commuting gauge groups, hadronic and leptonic. This divides such models into three sectors, being, hadrons, leptons, and a third unconventional set of (presumably high-mass) scalar mesons which serve to connect the two "known" worlds. Spontaneous breakdown induces appropriate masses and all usual strong, weak, and electromagnetic couplings. Intimate connections are seen between these three fundamental forces. (auth)

16602 FINITE N-P MASS DIFFERENCE IN SPONTANEOUSLY BROKEN GAUGE THEORIES. Freedman, Daniel Z. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, Long Island, New York 11790); Kummer, Wolfgang. Phys. Rev. D 7: No. 6, 1829-1835 (15 Mar 1973).

In two examples of spontaneously broken gauge theories in which electromagnetic isodoublet mass differences are finite, the sign of Δm_{n-p} for pointlike protons and neutrons is negative, although the general formula for mass differences in gauge theories allows both signs. (auth)

16603 PARTON MODEL WITHOUT WEE PARTONS. Segre, Gino (Aspen Center for Physics, Aspen, Colorado 81611). Phys. Rev. D 7: No. 4, 1208-1211 (15 Feb 1973).

We consider the application to electromagnetic processes of a parton model in which the mechanism for high-subenergy partons to interact is by exchange of chains or Reggeons which in turn emit particles; wee partons are consequently not present in the model. (auth)

16604 GAUGE INVARIANCE IN COMPTON SCATTERING. Müller, H. J. W. (Fachbereich Physik der Universität Trier-Kaiserslautern, Kaiserslautern, West Germany); Vahedi-Faridi, N. Phys. Rev. D 7: No. 4, 1254-1255 (15 Feb 1973).

The scattering of vector mesons off a pseudoscalar-meson target is considered and the requirements of gauge invariance in the limit of

vanishing mass of the vector meson are discussed. Explicit conditions are obtained which ensure the vanishing of helicity amplitudes of longitudinal helicity components in this limit and it is shown that the transition to the limit is smooth. (auth)

16605 SCALING BEHAVIOR OF THE CUTOFF VECTOR GLUON MODEL. Fishvane, Paul M. (Physics Department, University of Virginia, Charlottesville, Virginia 22901); Sullivan, J. D. Phys. Rev. D 7: No. 6, 1879-1888 (15 Mar 1973).

We compute in a leading-logarithm approximation the deep-inelastic scattering and annihilation structure functions in the Bjorken limit after appending a transverse-momentum cutoff to the neutral vector-gluon model. Detailed results such as the analyticity relation and the reciprocal relation between scattering and annihilation are sensitive to the method of cutoff. Although the structure functions obey Bjorken scaling, scaling is broken channel by channel, unlike the cutoff γ_5 field theory. This feature is reflected by the multiplicity which grows $\sim \ln q^2$ in the cutoff vector-gluon model. (auth)

16606 PARASTATISTICS, DYONS, AND DYONIUM. Mahanthappa, K. T. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80302). Phys. Rev. D 7: No. 4, 1028-1031 (15 Feb 1973).

It is pointed out that if the bound state (BS) of two normal or para particles (say, dyons) having electric and magnetic charges (e_1,g_1) and (e_2,g_2) is a normal or para particle, (i) the BS is a normal or para boson if both dyons are normal or para bosons or normal or para fermions, and (ii) it is a normal or para fermion if one dyon is a normal or para boson and the other a normal or para fermion. This observation, combined with the regular connection between spin and statistics and the Dirac quantization condition, $e_1g_2-e_2g_1=\nu$, yields only integer values of ν for the BS. Thus the dyonium model of proton expounded by Barut is invalidated. But it can be rescued if the regular connection between spin and statistics is violated for dyons so that one of the spinless dyons, of which the dyonium is made, is a normal boson and the other a spin-0 fermion. Comments are made concerning this violation along the lines of Greenberg and Messiah. Also, comments are made concerning the significance of the O(4,2) wave equation by Barut in the relativistic domain. (auth)

16607 LIGHT-CONE ALGEBRA, FIELD-CURRENT IDENTITY, AND DEEP-INELASTIC SCATTERING. Arnowitt, R.; Friedman, M. H.; Nath, P. (Department of Physics, Northeastern University, Boston, Massachusetts 02115). Phys. Rev. D 7: No. 4, 1197-1207 (15 Feb 1973).

We reproduce the full content of the Fritzsch-Gell-Mann light-cone algebra (originally derived using the quark model) for deep-inelastic lepton-nucleon scattering using currents given by the field-current identity. These currents are modified by dilaton clothing from the usual low-energy vector-dominance form by the principles of scale invariance to possess a scale dimension three (which is the dimension of the currents in the quark model). The calculation is performed by the technique of an effective Lagrangian to be used to first nonvanishing order, and the forms of the interactions needed to maintain the light-cone algebra are determined. The usual quark-parton results are explicitly obtained, e.g., the vanishing of $q^2\sigma_L$ in the deep-inelastic limit, the relations between electron and neutrino structure functions, etc. The Callan-Gross sum rule is examined and shown to be consistent with the above results. (auth)

16608 RUNAWAY MODES IN DIPOLE ELECTRODYNAMICS WITH SHADOW STATES. Chiang, C. C. (Center for Particle Theory, University of Texas, Austin, Texas 78712). Phys. Rev. D 7: No. 6, 1725-1732 (15 Mar 1973).

In this paper we study the model in which a nonrelativistic harmonically bound electron interacts with the dipole part of the electromagnetic field. With the introduction of a shadow electromagnetic field, we find that, in contrast with the conventional treatment, the unpleasant runaway modes do not occur. The scattering states of a physical photon scattered by an electron are also given, and it is shown that these physical states form a set of orthonormal states. (auth)

16609 PHOTOPRODUCTION OF PIONS IN THE σ MODEL WITH PADE APPROXIMANTS. Chan, W. K. New Haven; Yale Univ. (1972). 133p. University Microfilms Order No. 73-14,096. Thesis (Ph. D.).

The dominant multipole amplitudes E_{1+} and M_{1+} for the reactions $\gamma p \to \pi^0 p$ and $\gamma p \to \pi^+ n$ are studied in the linear σ model with minimal electromagnetic interaction. The perturbation series for these amplitudes are computed in the one loop approximation and their [2,2] Padé approximants are studied. It is found that these approximants give a good description of the P(3,3) resonance of the final state pion-nucleon system. The point-wise agreement of these amplitudes with experiment is good for the case of π^+ production while for the case of π^0 production the agreement is only qualitative. The only adjustable parameter of the calculation is the four-pion coupling constant. The mass of the σ meson is taken to be around 700 MeV. (Diss. Abstr. Int., B)

16610 INELASTIC e-p SCATTERING PROCESS INVOLVING DETECTED FINAL PROTON. Sato, M. (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 256-266(Jan 1973).

A phenomenological and simple model based on a statistical assumption is proposed for the semi-inclusive process $e + p \to e + p + X$ and the inclusive one $e + p \to e + X$. It is assumed that secondary pions in these processes are emitted with the Maxwell distribution. The gross feature of the electroproduction is reproduced by calculating the multiple-particle phase space with the isotropical momentum cut in the cm frame of the γ-system. The parameters in the model are adjustable so as to fit the experimental data. (auth)

16611 HIGH ENERGY PHOTO-REACTIONS AND GENERALIZED VECTOR MESON DOMINANCE MODEL IN THE RELATIVISTICALLY EXTENDED QUARK MODEL. Kobayashi, T. (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 49: No. 1, 282-292(Jan 1973).

A generalized vector meson dominance model which is derived from the quark model with the relativistically extended internal structure is applied to high energy photo-reactions, i.e., $e^+e^- \to$ vector meson (V_λ^0), Compton scattering and photoproductions of vector mesons. In this model it is predicted that infinite numbers of vector mesons must be introduced to describe the currents of hadrons. It is shown that the discrepancy among photo-vector meson transition couplings derived from the reactions $e^+e^- \to V_\lambda^0$, $\gamma p \to \gamma p$, $\gamma d \to \gamma d$ and $\gamma p \to V_\lambda^0 p$ with the aid of the usual vector meson dominance model in which only ρ-, ω- and ϕ-mesons are adopted is corrected and the couplings of all the reactions can consistently be reproduced by introducing the infinite numbers of vector mesons predicted by our model. It is also shown that the contributions of mesons other than ρ, ω and ϕ are expected to become remarkable at large momentum transfers. Predictions of $\Gamma(V_\lambda^0 \to e^+e^-)$ and $d\sigma/dt\ (\gamma p \to V_\lambda^0 p)|_{t=0}$ are presented. Comparison of our results with some experiments on the first-excited vector meson is also carried out. (auth)

16612 RANGE, LIGHT-CONE DOMINANCE AND SCALING AT LOW Q^2 IN ELECTROPRODUCTION. Jaffe, Robert L. (Stanford Linear Accelerator Center, Stanford University, California, 94305). Ann. Phys. (N.Y.) 75: No. 2, 545-561 (Feb 1973).

The analysis of light cone singularities is used to connect the y,P, or range, dependence of the current correlation function with the Q^2 dependence of the inelastic electroproduction structure functions. We study for what regions of the Q^2, ν plane and for what y,P dependence the leading light-cone singularity dominates contributions from less singular terms with the same y,P dependence. When the leading singularity can be shown to dominate for a particular region of Q^2 and ν, we study whether this implies scaling for νW_2 in that kinematic region. It is shown that a division of the current correlation function into short and long range contributions is fundamentally ambiguous and not related to scaling at low Q^2. Short range terms which are shown to be light-cone dominated for all Q^2 so long as $\nu \to \infty$, are found but are shown not to scale at low Q^2 and to be indistinguishable from corrections to long range terms which produce the leading Regge behavior. We show that leading Regge terms may receive contributions far away from the light cone for small virtual photon mass, but that light-cone dominance and scaling are recovered when the photon mass is taken very large. (auth)

16613 EVIDENCE FOR THE ϕ-MESON CONTRIBUTION TO VACUUM POLARIZATION OBTAINED WITH THE ORSAY e^+e^- COLLIDING-BEAM RING. Augustin, J. E.; Courau, A.; Dudelzak, B.; Fulda, F.; Grosdidier, G.; (and others) (Laboratoire de l'Accélérateur Linéaire, Centre d'Orsay de l'Université de Paris-Sud, 91 Orsay, France). Phys. Rev. Lett. 30: No. 10, 462-465 (5 Mar 1973).

The absolute cross section for the $e^+e^- \to \mu^+\mu^-$ reaction was measured in a 12-MeV total cm energy range centered at the mass of the ϕ meson. We observe a deviation from the s^{-1} dependence of the cross section predicted by quantum electrodynamics when hadronic modifications are neglected. A good fit to the data requires that one take into account $\gamma \to \phi \to \gamma$ virtual transitions. Direct evidence for such a vacuum-polarization effect is thus established with a confidence level higher than 0.99. (auth)

16614 PION ELECTROMAGNETIC SELF-ENERGY IN THE PRESENCE OF SPIN-TWO GRAVITONS. Huskins, J. (Physics Department, Imperial College, London SW7, England). Phys. Rev. D 7: No. 6, 1934-1935 (15 Mar 1973).

The π^+-π^0 mass difference is computed to lowest order in a model field theory which includes spin-two gravitons. This is compared with an earlier result in which spin-zero gravitons were considered. (auth)

16615 ENERGY EIGENVALUES FOR CHARGED PARTICLES IN A HOMOGENEOUS MAGNETIC FIELD—AN APPLICATION OF THE FOLDY-WOUTHUYSEN TRANSFORMATION. Tsai, Wu-yang (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 7: No. 6, 1945-1948 (15 Mar 1973).

We find that the equation of motion for spin-1/2 and spin-1 particles with an anomalous magnetic moment in a homogeneous magnetic field can be diagonalized by applying the Foldy-Wouthuysen transformation. The energy-eigenvalues are then easily obtained by observation. (auth)

16616 RELATIVISTIC MOTION IN A UNIFORM MAGNETIC FIELD. Herrera, J. C. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 7: No. 6, 1567-1570 (15 Mar 1973).

The Lorentz-Dirac equation of motion for a particle moving in a uniform field is analyzed in detail. The perturbation solution obtained is exact to sixth order in the interaction constant $\lambda = 2e^3H/3m^2c^4$. We study the convergence of this solution and show explicitly how the radiated energy depends on the transverse energy and on the Schott energy. (auth)

16617 SCALING LAWS AND EQUAL-TIME COMMUTATORS. Frishman, Yitzhak; Yankielowicz, Shimon (Department of Nuclear Physics, Weizmann Institute of Science, Rehovot, Israel). Phys. Rev. D 7: No. 6, 1661-1668 (15 Mar 1973).

The relation between generalized scaling laws, or equivalently light-cone behavior of current commutators, and equal-time commutators is investigated. In particular, the finiteness of the Callan-Gross integrals over equal-time commutators does not imply Bjorken scaling. It can happen that W_2 or even $(1/\nu)W_2$ scales. Also, even in the cases of forward matrix elements, the correspondence between light-cone and short-distance singularities is not one-to-one in general. The various cases are investigated. Operator Schwinger terms and their relation to the longitudinal cross section are also discussed. (auth)

16618 DEFLECTION OF A RADIATING ELECTRON TRAVERSING AN INHOMOGENEOUS MAGNETIC FIELD. Shen, C. S. (Department of Physics, Purdue University, Lafayette, Indiana 47907). Phys. Rev. D 7: No. 6, 1938-1940 (15 Mar 1973).

The trajectory of a strongly radiating electron in a time-dependent inhomogeneous magnetic field is analyzed. The results are used to estimate the deflection of an electron beam entering a magnetic pulse with steep field gradient. (auth)

16619 DOMINANCE OF ELECTROMAGNETIC EFFECTS IN HIGH ENERGY HADRON AND PHOTON INDUCED REACTIONS. Berlad, G.; Dar, A.; Eilam, G.; Franklin, J. (Department of Physics, Technion - Israel Institute of Technology, Haifa, Israel). Ann. Phys. (N.Y.) 75: No. 2, 461-478 (Feb 1973).

It is argued that at high enough energy the electromagnetic interaction will dominate over the strong interactions in all reactions that can proceed via photon exchange. Important consequences of this possibility are discussed. Among them are the possibility of measuring meson and photon structure functions already in the energy range of the NAL machine, the possibility of a breakdown of isospin invariance at high energy and its possible verification at the ISR CERN machine, and the inequality between particle and antiparticle cross sections at high energy. (auth)

16620 SUPPRESSION OF THE LONGITUDINAL PARTS OF TWO-PARTICLE ELECTROPRODUCTION AMPLITUDES. Palmer, D. R. (Department of Physics, University of Toronto, Toronto, Canada). Phys. Rev. D 7: No. 7, 2206-2213 (1 Apr 1973).

A simple method is given for showing that the imaginary parts of two-particle electroproduction amplitudes corresponding to longitudinally polarized virtual photons are suppressed. The method applies to all two-particle final states, polarized and unpolarized targets, and all momentum transfers. The existence of the suppression is dependent on a fermion-constituent picture and on being in the scaling region. (auth)

16621 SOME CONSEQUENCES OF NONET SYMMETRY. Kenny, Brian G. (The Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 7: No. 7, 2156-2160 (1 Apr 1973).

Attention is drawn to the existence of certain similarities between predictions of the asymptotic nonet-symmetry model and the quark model. In particular, the electromagnetic decays of vector and pseudoscalar mesons and the decoupling of the ϕ meson from the nucleons is discussed. We find slight differences of prediction for certain electromagnetic decay rates which would have implications in choosing between the so-called quadratic and linear mass mixing formulas for pseudoscalar mesons. (auth)

16622 IMPROVED OPTIMAL BOUNDS USING THE WATSON THEOREM. Micu, M. (Institute of Atomic Physics, P. O. Box 35, Bucharest, Romania). Phys. Rev. D 7: No. 7, 2136-2138 (1 Apr 1973).

A method is presented to find an optimal lower bound on the quadratic functional integrals which appear in the derivation of bounds on the hadronic contribution to the muon magnetic moment, or on the K_{l3} form factors, when one knows that the function and its derivative take some definite values at the origin and that its phase is given on a part of the unitarity cut. (auth)

16623 e^+e^- CONTRIBUTION TO THE PHOTON STRUCTURE FUNCTIONS. Buchl, R. A. (Department of Physics, Arizona State University, Tempe, Arizona 85281). Phys. Rev. D 7: No. 7, 2139-2143 (1 Apr 1973).

The deep-inelastic differential cross section for the process $e^-+\gamma \to e^-+A$ is compared with the differential cross section for the purely quantum electrodynamical process $e^-+\gamma \to e^-+e^+e^-$. Explicit expressions emerge for the photon structure functions, $W\gamma_1(q^2,\nu)$ and $\nu W\gamma_2(q^2,\nu)$, in this approximation. We find a logarithmic factor in both structure functions which prohibits them from exhibiting scaling behavior. (auth)

16624 CALCULATION OF THE $\eta \to \pi\pi\gamma$ DECAY RATE WITH FINITE DISPERSION RELATIONS. Young, B.-L.; Lassila, K. E. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 7: No. 7, 2174-2182 (1 Apr 1973).

Finite-dispersion-relation techniques as developed by Aviv and Nussinov are employed to calculate the decay rate for $\eta \to \pi^+\pi^-\gamma$ in an essentially parameter-free manner. The amplitude for this decay is obtained by crossing from the scattering process $\eta\pi \to \pi\gamma$ which has the A_2 resonance in the s and u channels and the ρ trajectory in the t channel. A single Breit-Wigner resonance of width 85 MeV for the A_2 meson directly leads to a prediction for the rate and photon momentum distribution in good agreement with experimental measurements. The so-called broad-narrow model can give agreement if couplings of each component to $\eta\pi$ and $\pi\gamma$ are properly chosen, but all pictures of the A_2 with two narrow components give inadequate results. (auth)

16625 REGGE AND PARTON MODELS FOR PHOTON-PHOTON ANNIHILATION. Walsh, T. F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 7, 2152-2156 (1 Apr 1973).

We discuss some of the questions which can be investigated in the two-photon part of $e^-+e^- \to e^-+e^-+$hadrons when the electrons are scattered at finite momentum transfer. Discrimination of Regge and parton models for this process is possible in principle by studying the transverse helicity amplitudes. In some parton models the amplitudes are predicted exactly for limits where $s = (q_1+q_2)^2$ and $|q_1^2|$ and $|q_2^2|$ all approach infinity with constant ratios; this is a new sort of scaling limit, inaccessible in inelastic electron-proton scattering. (auth)

16626 ELECTROPRODUCTION AND PHOTOABSORPTION IN A MODEL OF HIGHER BARYON COUPLINGS. Sood, Sudhir K.; Mitra, A. N. (Department of Physics and Astrophysics, University of Delhi, Delhi-7, India). Phys. Rev. D 7: No. 7, 2111-2125 (1 Apr 1973).

We have studied the two related problems of inelastic e^--N scattering and the total photoabsorption cross section in a relativistic SU(6) $\times$O(3) model of higher baryon couplings being developed over the last few years. The hypothesis of duality is incorporated for both these photonic processes by summing over an infinite sequence of s-channel resonances, the facility for which is provided in this model of $B_L B(P,V)$ couplings through a simple structure of the form factor for the supermultiplet transition $(L^P \to 0^+)$ and a "Regge universality" condition on the "reduced" coupling constants. A slight variant of this form factor, which has been applied successfully to several two-body processes recently, is found to give rather good fits to the resonance production region of inelastic e^--N scattering over a wide range of imput data. The difference $(\Delta\sigma_1)$ of the total photoabsorption cross section on the proton and the neutron targets is also reproduced quite accurately over the whole range of available data. For these two processes, the higher-spin $(J=L+1/2,\ J=L+3/2)$ states are found to produce dominant contributions over those of the lower-spin $(J=L-1/2)$ states. A comparison of this pattern with a corresponding one operative for the evaluation of electromagnetic masses within this model prompts us to infer almost a "causal" relationship between the positive value of $\Delta\sigma_1$ on the one hand and the traditional negative value of $(\delta m_p - \delta m_n)$ on the other. However, an important shortcoming of this model is its inability to reproduce the scaling region of deep-inelastic e^--N scattering for very high incident electron energies ($\epsilon > 10$ GeV). This is presumably because of the absence in this model of a mechanism for the inclusion of daughter trajectories, whose contributions are expected to be progressively more important as the energy is increased. (auth)

16627 PHENOMENOLOGICAL STUDY OF N$\Delta\gamma$ FORM FACTORS. Nath, N. R. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). Phys. Rev. D 7: No. 7, 2046-2058 (1 Apr 1973).

Single- and double-arm electroproduction data, on the reaction $e+p \to e+\Delta^+(1236)$, and photoproduction data on $\gamma p \to \Delta^+$ are analyzed in terms of $\gamma p\Delta$ form factors which are defined analogously to nucleon form factors by a definite prescription. Using the parametrization $G_M = C_2(1+|q^2/C_1)^{-2}$ for the M1 form factor defined in this way, and adopting different forms of R $(=\sigma_S/\sigma_T)$, we find that $C_1^2C_2$ lies close to $(0.71\ \text{GeV}^2)^2$, a value predicted from the SU(6) symmetry in the $|q^2| \to \infty$ limit. The fitted values of $C_1^2C_2$ are also consistent with the requirement of duality, as proposed by Bloom and Gilman. (auth)

16628 LEPTONIC DECAYS OF VECTOR MESONS AND A UNITARY-SINGLET CONTRIBUTION TO THE HADRONIC ELECTROMAGNETIC CURRENT. Wienke, B. R. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. D 7: No. 7, 2253-2256 (1 Apr 1973).

Following some original ideas of Salam, Mathur and Okubo further theoretical consideration is given to a possible singlet contribution to the electromagnetic current of hadrons using spectral sum rules connecting the leptonic decays of vector mesons. Unfortunately, experimental uncertainty prevents meaningful analysis and conclusion. (auth)

16629 OBSERVATION ON INELASTIC ELECTRON SCATTERING DATA. Chen, T. W. (Department of Physics, New Mexico State University Las Cruces, New Mexico 88001). Phys. Rev. D 7: No. 7, 2267-2269 (1 Apr 1973).

It is shown that the deep-inelastic electron scattering data points for the structure function $\nu W_2(\nu,\kappa)$ in the scaling region can be extremely well represented by a simple function $1.82(\omega-1)^3/\omega^{3.6}$, where $\omega=2M_p\nu/\kappa$. (auth)

16630 INELASTIC STRUCTURE-FUNCTION RELATIONS FROM SUMS OF DIRECT-CHANNEL RESONANCES. Close, F. E.; Gilman, F. J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 7, 2258-2261 (1 Apr 1973).

Relations among the cross sections for both spin-dependent and spin-independent scattering of electrons and neutrinos on protons and neutrons are derived by summing over direct-channel nucleon resonances in the symmetric quark model. The relations previously derived in the three-quark-parton model are shown to correspond in the resonance approach to a sum over a particular combination of resonances belonging to the 56- and 70-dimensional representation of SU(6), which ensures the absence of exotic exchanges in the t channel of the current-nucleon elastic scattering amplitude. (auth)

16631 BEHAVIOR OF THE ANGULAR DISTRIBUTION IN THE PAIR ANNIHILATION PROCESS AND ELECTRON–ELECTRON SCATTERING WITH LORENTZ TRANSFORMATION. Hernandez Chavez, O. L. Y. Mexico City; Instituto Politecnico Nacional (1973). 55p. (In Spanish).

Thesis.

The rule given by J. R. Terrall for the transformation of an angular distribution for the cases of electron–electron dispersion and electron–positron pair annihilation is illustrated. The Dirac equation is obtained and the theory of Dirac particle and photon propagators is developed. The transverse section is calculated and is put into a form simple enough to show its invariance. From the transverse section the angular distribution is calculated as the product of an invariant quantity and a noninvariant quantity. The fundamental fact on which the transformation of an angular distribution is based is the invariance of quadrivector products. A first example is the transformation of the angular distribution of the center-of-mass system to any system, particularly the laboratory system, for the case of electron–electron dispersion. This is treated in the nonrelativistic limit. The second case analyzed is the pair annihilation with the transformation of the angular distribution of the laboratory system to the center-of-mass system. The results obtained in the first case agree with previous results. The results of the second case are original. (tr-auth)

16632 PARTON MODEL, DUALITY, AND DEEP-INELASTIC SINGLE-PARTICLE DISTRIBUTIONS. Chaichian, M.; Kitakado, S.; Pallua, S.; Zarmi, Y. (CERN, Geneva). Nucl. Phys.; B58: No. 1, 140-156(1973).

Within the quark parton model the two-component duality idea is generalized to single hadron inclusive distributions in deep-inelastic scattering. The discussion is limited to the current fragmentation region. The number of independent distribution functions is reduced. Relations as well as inequalities among the structure functions are obtained. In particular, the excess of π^+ over π^- in the electroproduction off a proton comes out as a consequence and the differential cross section for $e^+e^- \to \pi +$ anything is fully determined by the electroproduction of pions on nucleons. (auth)

16633 BACKWARD $\gamma p \to \pi^+ n$ AMPLITUDE. Alvarez-Estrada, R. F. (Univ. Autonoma, Madrid); Carreras, B.; Sanchez Gomez, J. L. Nucl. Phys.; B58: No. 1, 254-260(1973).

A detailed numerical study of the phase of the backward $\gamma p \to \pi^+ n$ amplitude is presented. Use is made of experimental data, analyticity and the results of the multipole analysis. A prediction of the phase up to the third resonance region is given. (auth)

16634 UNIFIED THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS WITH $\Delta I = 1/2$ RULE. Yang, T. C. (Univ. of California, San Diego, La Jolla). Nucl. Phys.; B58: No. 1, 283-294(1973).

An SU(2) ⊗ U(1) gauge theory of weak and electromagnetic interactions satisfying the $\Delta I = \frac{1}{2}$ rule is proposed, which has the following characteristic: (i) A neutral boson Z, coupling to the neutral strangeness-changing current is used in addition to the usual charged ones, to give the $\Delta I = \frac{1}{2}$ rule in the standard fashion. Couplings are chosen such that the Z decouples from the observed leptons, in order to agree with experiment. (ii) It is assumed that the $|\Delta Y| = 2$ transitions due to neutral vector-boson exchange cancel the $|\Delta Y| = 2$ contributions due to charged vector-boson exchange. This constrains the Cabibbo angle in a manner consistent with experiment. (auth)

16635 DRELL–YAN–WEST RELATION FOR DEEP INELASTIC AND ELASTIC FORM FACTORS. Ezawa, Z. F. (Tokyo Univ.). Nucl. Phys.; B58: No. 1, 295-300(1973).

It is shown, in a scalar current model, that the Drell–Yan–West relation is valid in the form of an inequality. Namely, it is proved that the elastic form factor decreases asymptotically as, or more rapidly than, $\sim|t|^{-\frac{1}{2}}$, provided that the deep-inelastic structure function behaves near threshold as $\sim(1-\omega)^{1/2}$. (auth)

16636 COMPTON SCATTERING INDUCED BY AN INTENSE BEAM. Billoir, P. (College de France, Paris). Compt. Rend., Ser. A, B; 276: No. 13, 499-502(26 Mar 1973). (In French).

The possibility of Compton scattering induced by a beam of coherent photons (analogous to induced atomic emission) was investigated using a simplified quantized model; a classical interpretation of the effect is proposed for a particular case in terms of the Bragg reflection of stationary electromagnetic waves by a lattice. (auth)

16637 MAXWELL GROUP AND THE QUANTUM THEORY OF PARTICLES IN CLASSICAL HOMOGENEOUS ELECTROMAGNETIC FIELDS. Schrader, R. (Harvard Univ., Cambridge, MA). Fortschr. Phys.; 20: No. 12, 701-734(1972).

Covariant solutions of the Dirac (and Klein–Gordon) equation in a homogeneous classical electromagnetic field are constructed. This is done using the symmetry group of the equation, the Maxwell group. These covariant solutions are obtained starting from solutions in the frame where the electromagnetic field is described by a magnetic field pointing in the 3-direction and then using the theory of induced representations. (auth)

16638 COHERENT $e^- - e^+$-PAIR PRODUCTION AND BREMSSTRAHLUNG ON THE CORUNDUM CRYSTAL. Avakyan, R. O.; Armaganyan, A. A.; Darbinyan, S. M. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 7: No. 5, 311-319(1972). (In Russian).

The possibility of the application of single crystal corundum for the coherent $e^- - e^+$-pair production and bremsstrahlung is investigated. (auth)

16639 NUCLEON FORM FACTOR IN A SMOOTHED VENEZIANO-LIKE MODEL AND THE REACTION $e^+e^- \to p\bar{p}$. Antoniou, N. G.; Georgalas, C. G.; Kouris, C. B.; Papaioannou, G. M. (Democritos Nuclear Research Centre, Attikis, Greece). Acta Phys. Austr.; 36: No. 1, 92-98(1972).

The reaction $e^+e^- \to p\bar{p}$ is studied using a smoothed Veneziano-like model for the proton form factor. The model is able to describe in a satisfactory way the data in the space-like region, and the preliminary ADONE data on the reaction $e^+e^- \to p\bar{p}$. A maximum cross section, $(e^+e^- \to p\bar{p}) = 0.55 \times 10^{-33}$ cm^2 is predicted for $E_{cm} = 1.9$ GeV, and a broad structure for $2 \le E_{cm} \le 2.2$ GeV, associated with a high mass daughter. (auth)

16640 PION CHARGE RADIUS FROM CURRENT ALGEBRA SUM RULE AND SHORT RANGE CORRELATION MODEL. Aubrecht, C. J.; Hwa, R. C. (Univ. of Oregon, Eugene). AT(45-1)-2230. Phys. Lett., B; 44B: No. 6, 515-517(11 Jun 1973).

Starting from the Fubini-Dashen-Gell-Mann sum rule, the slope of the pion electromagnetic form factor at $t = 0$ is related to the rotational properties of the photopion production amplitudes. When the pion's charge radius is calculated with a simple short range correlation model for the production amplitudes (diffractive processes being forbidden), the result is $\langle r_\pi^2\rangle^{\frac{1}{2}} = 0.8$fm. (auth)

16641 LIGHT CONE AND PHOTON-HADRON INTERACTIONS. Brandt, R. A. (New York Univ., NY). Fortschr. Phys.; 20: No. 10, 571-594(1972).

The discussion of the light cone for photon–hadron interactions covers scaling functions, scaling at SLAC, connection with R-limit, short-distance expansions, free field LC expansions, LC expansions in perturbation theory, lessons from SLAC, canonical formalism, massive muon-pair production, and LC controlled MDR's. (JFP)

16642 THRESHOLD RELATION BETWEEN DEEP-INELASTIC ELECTRON SCATTERING AND ELECTRON-POSITRON ANNIHILATION. Gatto, R. (Istituto di Fisica dell' Universita, Roma

and Istituto Nazionale di Fisica Nucleare, Sezione di Roma, Roma, Italy); Menotti, P.; Vendramin, I. Phys. Rev. D 7: No. 8, 2524-2528 (15 Apr 1973).

A presumably general relation between the deep–inelastic scaling functions and those of electron–positron annihilation is proved for certain classes of graphs, even in the absence of analytic continuation between the two channels. (auth)

16643 DEGENERACY OF RELATIVISTIC CYCLOTRON MOTION. Yanagawa, Sadaaki (Department of Applied Physics, Faculty of Engineering, University of Tokyo, Tokyo, Japan). Phys. Rev. D 7: No. 8, 2412-2414 (15 Apr 1973).

The quantum–mechanical problem of the relativistic cyclotron motion of a charged particle in a uniform magnetic field is solved by consideration of the symmetry which the system obeys. It is shown that its symmetry is isomorphic to the Lie group called G(0,1) or G(1,0), and doubly degenerate infinite series of wave functions with a constant energy eigenvalue are labeled by the eigenvalues of the operators H^2, L_z+S_z, and S_z. Here H is the relativistic Hamiltonian referred to in the present problem, and L_z and S_z are the usual orbital and spin angular momentum operators, respectively. (auth)

16644 ISOBAR ANALYSIS OF $\gamma p \rightarrow \eta p$. Hicks, H. R. (Department of Physics, Carnegie–Mellon University, Pittsburgh, Pennsylvania 15213); Deans, S. R.; Jacobs, D. T.; Lyons, P. W.; Montgomery, D. L. Phys. Rev. D 7: No. 9, 2614-2626 (1 May 1973).

An analysis of the available data below 2.24–GeV c.m. energy for the process $\gamma p \rightarrow \eta p$ yields values of $G = \Gamma(R \rightarrow \gamma p)\Gamma(R \rightarrow \eta p)$ for several s–channel resonances, R. By varying the details of the direct–channel isobar model it found that the values of G are reasonably model–independent. When these values are combined with information from other reactions it is possible to calculate electromagnetic widths for the important resonance states in this process. These include essential contributions from S_{11} and P_{11} states; in addition; admixtures of P_{13}, D_{13}, F_{17}, and G_{17} resonances are also needed in order to obtain a good fit to the data. An excellent fit is found by including some recently conjectured stray baryonic states which do not couple significantly to the πN channel. (auth)

16645 SATURATION OF THE DRELL–HEARN–GERASIMOV SUM RULE. Karliner, Inga (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 9, 2717-2723 (1 May 1973).

The Drell–Hearn–Gerasimov sum rule for the forward spin–flip amplitude of nucleon Compton scattering is decomposed into separate sum rules originating from different isospin components of the electromagnetic current. The resulting sum rules are reexamined using recently available analyses of single–pion photoproduction in the region up to photon laboratory energies of 1.2 GeV. All three sum rules receive important nonresonant as well as resonant contributions. The isovector sum rule whose contributions are known best is found to be nearly saturated, lending support to the assumptions underlying the sum rules. The failure of the isoscalar–isovector sum rule to be saturated is then presumably to be blamed on inadequate data for inelastic contributions. (auth)

16646 LEPTONIC DECAY OF VECTOR MESONS IN AN ALGEBRAIC MODEL FOR HADRONS. Böhm, A. (Center for Particle Theory, University of Texas, Austin, Texas 78712). Phys. Rev. D 7: No. 9, 2701-2709 (1 May 1973).

The decay rates for V–e$\bar{e}$ are calculated using an octet of transition operators that has been introduced previously in the framework of an algebraic model. The results are compared with experimental data, and restrictions on the symmetry–breaking relations for these transition operators are obtained which are shown to be the analog of other well–known symmetry–breaking relations. (auth)

16647 QUESTION OF DIRECT MEASUREMENT OF THE QUARK CHARGE. Farrar, Glennys R.; Rosner, J.L. (Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 9, 2747-2751 (1 May 1973).

Feynman has suggested that the average charge of hadrons produced in a particular kinematic region in deep–inelastic lepton scattering reflects the charge of the struck constituent. It is shown that such hadronic tests for the quark charge depend on specific properties of the final–state interaction even when the conditions suggested by Feynman for the validity of these tests are satisfied. Such tests are used here to distinguish among various classes of production models. (auth)

16648 NEW TECHNIQUE FOR VERTEX GRAPHS. Levine, M. J. (Department of Physics, Carnegie–Meilon University, Pittsburgh, Pennsylvania, 15213); Roskies, R. Phys. Rev. Lett. 30: No. 16, 772-774 (16 Apr 1973).

We introduce a new technique which we use to analytically compute six graphs contributing to the magnetic moment of the electron in sixth order. (auth)

Weak

Refer also to abstract 16852.

16649 (DESY-73/13) HOW TO ANALYSE VECTOR MESON PRODUCTION IN INELASTIC LEPTON SCATTERING. Schilling, K.; Wolf, G. (Deutsches Elektronen Synchrotron, Hamburg (West Germany)). Apr 1973. 41p. Dep. NTIS (U. S. Sales Only) $4.25.

The kinematics of the process $lN \rightarrow lNV$, is studied in the one–photon approximation for unpolarized as well as polarized leptons l. The vector meson spin density matrix is expressed in terms of the s–channel helicity amplitudes in the hadron cms and the vector meson decay angular distribution is discussed. The use of longitudinally polarized lepton beams is found to increase considerably the amount of information that can be deduced from the decay distribution. With longitudinal beam polarization it is possible to separate all 26 observable independent density matrix elements into contributions from natural and unnatural parity exchange in the t–channel, respectively. (auth)

16650 (JINR-D-6840, pp 175-181) DETAILED INTERFERENCE SHOWN IN K^0 MESON NONLEPTONIC DECAY. Votruba, Ya.; Gladki, Ya.; Novak, M.; Prokesh, A. (Inst. of Physics, Prague). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16651 (JINR-D-6840, pp 230-236) PROBLEMS OF THE UNITARITY EVOLUTION OPERATOR AND SUPPOSITION PRINCIPLE. Lokaichek, M. (Inst. of Physics, Prague). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16652 (JINR-D-6840, pp 386-398) PROBLEMS IN WEAK INTERACTION THEORY. Bilen'kii, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16653 (NP-19799) EXACT BOUNDS FOR THE FORM FACTOR OF K_{13} DECAY. Tataru, L. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1972. 24p. Dep. NTIS (U. S. Sales Only) $3.25.

Assuming the Callen–Treiman and Dashen–, Li, Pagels, Weinstein relations, exact inequalities for K_{13} scalar form factor f(t) and its derivatives were studied. These inequalities are too stringent to fit with the experimental data. Only for a very large value of the propagator $\Delta(0)$ of the divergence of the strangeness changing current at zero momentum there is a better agreement. Various causes of this disagreement are analyzed. (auth)

16654 DEFORMED CURRENT ALGEBRA AND COMPUTATION OF THE CABIBBO ANGLE. Oehme, Reinhard (The International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. D 7: No. 4, 1162-1169 (15 Feb 1973).

The empirical suppression factor for strangeness–changing weak amplitudes (Cabibbo angle θ) is related to symmetry–breaking effects in the hadronic weak current. The correction of the octet currents introduces one coefficient ξ, which is a function of the parameter c appearing in the quark mass matrix $M=\lambda_0+c\lambda_8$, and which is identified with $\tan\theta$. The modified current components satisfy a deformed SU(3) $\times$SU(3) algebra, but the subalgebra of chiral SU(2) $\times$SU(2) remains unchanged. The assumption is made that the weak interactions conserve strangeness in the soft–pion limit $c=-\sqrt{2}$. With this boundary condition, and the requirement of Hermitian current components, the expression $\tan\theta=1-(1/2)c^2$ is obtained in lowest, nontrivial order of symmetry breaking. Since the parameter c can be related to meson mass splittings, one finds $\tan\theta\simeq 0.22$ with $c=-1.25$. The problem of anti–Hermitian current corrections is discussed briefly. (auth)

16655 $\Delta I=1/2$ RULE IN NONLEPTONIC WEAK INTERACTIONS. Lee, Benjamin W.; Treiman, S. B. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 7: No. 4, 1211-1216 (15 Feb 1973).

We investigate whether the $\Delta I=1/2$ rule for weak nonleptonic interactions can be embedded into unified theories of the weak and electromagnetic interactions. In such theories weak interactions are mediated not only by (gauge) vector–boson exchange, as usually envisaged, but also through exchange of Higgs scalar bosons. Although the former contributions cannot (it seems) be arranged to have a pure $\Delta I=1/2$ structure, we discuss a model in which the latter can be so arranged. Owing to strong–interaction complexities the effective strengths of these two sources of weak interactions cannot easily be assessed. The discussion nevertheless emplasizes the possibility that Higgs–exchange effects may have a significant role for the $\Delta I=1/2$ question. (auth)

16656 DIVERGENCE CANCELLATIONS IN SPONTANEOUSLY BROKEN GAUGE THEORIES. Kummer, Wolfgang (Department of Physics, University of Pennsylvania, Philadelphia 19104); Lane, Kenneth. Phys. Rev. D 7: No. 6, 1910-1923 (15 Mar 1973).

An extremely simple method is presented to calculate unambiguously higher-order corrections in the unitary (U) gauge of theories with spontaneously broken gauge symmetries. Manipulating Feynman integrals in coordinate space, the spurious nonrenormalizable infinities of this gauge are isolated in the form of (contracted) Feynman graphs. Without making reference to any specific global regularization scheme, the complete cancellation of these graphs is demonstrated in the cases of fermion-fermion scattering to fourth order in the Abelian model considered by Appelquist and Quinn and for the similar neutrino scattering in Weinberg's $SU(2)_L xY$ model. The reason for such complete cancellation is seen to be a consequence of the algebraic structure of the equal-time commutators among currents, their divergences, and various fields. This structure, of course, is dictated by the original gauge symmetry. As a check on our methods, the weak muon anomaly in Weinberg's model is calculated, and agreement is found with the (gauge-invariant) results of other authors. (auth)

16657 DEEP INELASTIC LEPTON-NUCLEON SCATTERING AND THE CORE STRUCTURE OF NUCLEONS IN THE FRAMEWORK OF THE QUARK-PARTON MODEL. Kim, B. R.; Rodenberg, R. (Technische Hochschule, Aachen). Progr. Theor. Phys. (Kyoto); 49: No. 1, 267-275(Jan 1973).

Assuming the integrals of the structure functions over the scaling variable $x = -q^2/2\nu$ to be finite, relations for the "parton-core" structure of nucleons are derived. These relations allow us to test the commonly used assumption about the "parton-core" of a nucleon as an equal mixture of quarks of all types and the assumption of charge symmetry and equal distribution of the nucleon momentum among the different types of quarks. (auth)

16658 NEUTRAL LEPTON CURRENTS. Kobler, O.; Urban, P.; Zingl, H. F. K. (Univ., Graz). Acta Phys. Austr.; 36: No. 2, 128-136(1972).

The existence of neutral currents produced by a Fierz transformation from the usual charged currents is assumed. The decay, $e^- + e^- \to \mu^- + \mu^-$ and the parity violating of $e^- + e^+ \to \mu^- + \mu^+$ are calculated in the intermediate boson picture. The last two processes may be observable, if the center of mass energy is about 100 GeV. One then introduces neutral hadron currents, and combines these with the lepton currents in the decay $K_L^0 \to \mu^- e^+$ to get a branching ratio of 10^{-13}. This value is a factor of 100 lower than the experimental upper limits for neutral lepton currents. (auth)

16659 THE SELF-COUPLING OF WEAK LEPTON CURRENTS IN HIGH ENERGY NEUTRINO AND MUON REACTIONS. Fujikawa, Kazuo (The Enrico Fermi Institute, University of Chicago, Chicago, Illinois, 60637). Ann. Phys. (N.Y.) 75: No. 2, 491-502 (Feb 1973).

The transverse momentum distribution of the muons in the reaction $\nu + (z) \to \nu + \mu + \bar{\mu} + (z)$ is discussed. The lower end of the energy spectrum of the muons in the previous study is also modified by using an improved interpolation formula. (auth)

16660 ADLER SUM RULE AND THE νP-νN BEHAVIOR. Tuan, S. F. (Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 7, 2092-2099 (1 Apr 1973).

It is shown that making just the minimal dynamical assumptions of the scaling-limit Nachtmann convex positivity domains based on the quark-parton model (or the equivalent light-cone approach), Regge asymptotics, rate of convergence based on the longitudinal coherence length (ω_0 for 90% saturation $\lesssim 50$), and the constraints of currently known electroproduction and neutrino data, the Adler inelastic sum rule can be satisfied with tantalizingly large $F_2^{\nu n}/F_2^{\nu p}$ ratio at low and intermediate values of ω ($\lesssim 5$). The possibility domain near threshold imposes, however, an increasingly severe strain on attempts to saturate the sum rule. Experimental implications for $\sigma_{\nu n,\nu p}$ and $\sigma_{\nu n}/\sigma_{\nu p}$ are also discussed. Finally, the theoretical basis for the Adler sum rule is briefly reappraised. (auth)

16661 HIGHER-ORDER CORRECTIONS TO SEMILEPTONIC WEAK PROCESSES. Appelquist, Thomas (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138); Bjorken, James D.; Chanowitz, Michael. Phys. Rev. D 7: No. 7, 2225-2235 (1 Apr 1973).

Using strong formulation of lepton-hadron universality, higher-order corrections to semileptonic weak processes are related to the high-energy behavior of lepton-lepton weak-scattering amplitudes. The "weak cutoff" estimates of ~ 4 GeV from the observed K_L-K_S mass difference and ~ 16 GeV from the absence of the decay $K_L \to \mu^+ \mu^-$ are interpreted as upper bounds on the center-of-mass energy at which cross sections for pure leptonic processes deviate significantly from the low-energy phenomenological predictions. A phenomenology for describing similar deviations in high-energy neutrino-nucleon reactions is developed. A sum rule relating such deviations is derived, as well as estimates of their order of magnitude using the parton model. (auth)

16662 TESTS FOR NEUTRAL CURRENTS IN WEAK PION PRODUCTION. Albright, C. H.; Lee, B. W.; Paschos, E. A. (National Accelerator Laboratory, P. O. Box 500, Batavia, Illinois 60510); Wolfenstein, L. Phys. Rev. D 7: No. 7, 2220-2225 (1 Apr 1973).

Bounds for neutral currents are derived for the inclusive pion production on isoscalar nuclei in the simple Weinberg and the Glashow-Iliopoulos-Maiani models. The bounds involve cross sections induced by neutrinos, antineutrinos, or combination thereof. Final-state interactions are included in the results. For isolated proton targets a bound is obtained in both models independent of any additional assumptions. All the quantities occurring in the bounds are in principle measurable. For those processes where data are not yet available, estimates are presented by allowing a wide range of variation for the unknown quantities. (auth)

16663 PION PRODUCTION IN SOME NEUTRINO-INDUCED REACTIONS. Castoldi, P. (Univ., Libre, Brussels). Nucl. Phys.; B58: No. 1, 315-324(1973).

A recent application of soft-pion techniques to the study of pion production in neutrino-induced reactions is examined and discussed. An alternative approach, also based on PCAC and current algebra, is proposed and approximate results concerning the production, not necessarily at rest, of a physical pion are derived. (auth)

16664 S-MATRIX APPROACH TO WEAK INTERACTIONS. Baran, S. A.; Barut, A. O. (Univ. of Colorado, Boulder). Fortschr. Phys.; 20: No. 9, 497-540(1972).

The content of weak interactions theory is formulated and rederived systematically in S matrix form. Also new results concerning the form of the amplitudes in various bases and the contribution of the higher intermediate states and the high energy behavior of weak interactions are presented. Various principles are contained in the corresponding S matrix language. Invariant and helicity amplitudes, unitarity, and some consequences of analyticity and unitarity are covered. (JFP)

16665 TEST OF WEAK NONLOCALITY IN HIGH ENERGY NEUTRINO EXPERIMENTS. Kainz, W. (Technische Hochschule, Vienna); Krummer, W. Acta Phys. Austr.; 36: No. 4, 377-390(1972).

The nonlocality of weak interactions may be observed rather easily in the quasielastic neutrino experiment, irrespective of the effects of hadronic interactions, provided such a nonlocality manifests itself in an energy dependence of the invariant functions at fixed momentum transfer. This is in fact the most general possibility for the four-fermion matrix-element at high energies. The possible effect as a function of the masses of the internal particles describing the nonlocality in a model of weak interactions which produces a nonlocal effect of this type is estimated. A comparison is made with what can be expected from a model with an intermediate vector boson (W) in which it is presumably much more difficult to disentangle the nonlocal effects of strong and weak interactions. (auth)

16666 ELECTROMAGNETIC CONTRIBUTION TO THE LEPTON-PAIR DECAY OF THE K^0_1 MESON. Smith, J.; Uy, Z. E. S. (The Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790). Phys. Rev. D 7: No. 9, 2738-2747 (1 May 1973).

If we assume that there is no anomalously large CP-violating $K^0_S \to \mu^+ \mu^-$ decay mode, then a possible conflict with a unitarity bound could arise similar to the present situation with $K^0_L \to \mu^+ \mu^-$. It is therefore important to have a reliable estimate of the electromagnetic contribution for $K^0_S \to \mu^+ \mu^-$. In this paper, we assume CP invariance (so $K^0_S \equiv K^0_1$) and give the results of a detailed calculation of both the real and imaginary parts of the $K^0_1 \to \mu^+ \mu^-$ amplitude based on contributions from 2γ, $\pi^+\pi^-$, and $\pi^+\pi^-\gamma$ states. (auth)

16667 PARITY-NONCONSERVING ASYMMETRY IN PROTON-PROTON SCATTERING. Brown, Virginia R. (Lawrence Livermore Laboratory, University of California, Livermore, California, 94550); Henley, Ernest M.; Krejs, Franz R. Phys. Rev. Lett. 30: No. 16, 770-772 (16 Apr 1973).

The effects of a weak force between nucleons can be studied directly through the scattering of longitudinally polarized nucleons on nucleons. We use distorted-wave theory to predict the dependence of the differential and total cross sections on the helicity of longitudinally polarized protons for elastic proton-proton scattering up to ~ 300 MeV. The weak force used is parametrized by ρ^0, ω^0, and two-pion exchanges. (auth)

16668 LEPTON ENERGY AND ANGLE DEPENDENCE THEOREMS FOR RADIATIVE NEUTRINO SCATTERING. Krishna, S.; Mani, H. S. (Department of Physics, Indian Institute of Technology, Kanpur 208016, India.). Phys. Rev. D 7: No. 9, 2691-2693 (1 May 1973).

Explicit expressions for dependence of cross sections for neutrino processes on lepton energy and angle variables have been obtained as

implications of lepton pair locality by Pais and Treiman. We show here that for neutrino processes accompanied by emission of a photon, a modified version of their theorem can be obtained giving dependence of the cross sections on the lepton-system variables. (auth)

16669 TESTS FOR A WEAK NEUTRAL CURRENT IN $l^{\pm}+N \to L^{\pm}+$ ANYTHING AT HIGH ENERGY. Derman, Emanuel (Department of Physics, Columbia University, New York, New York 10027). Phys. Rev. D 7: No. 9, 2755-2775 (1 May 1973).

Tests for a weak neutral current in high-energy inclusive $l^{\pm}$-N scattering are discussed, where l is a charged lepton and N a nucleon. If the polarization of the incoming lepton of the target nucleon can be varied, or the outgoing lepton's polarization observed, an unambiguous measurable consequence of such a current is parity violation. Some general expressions for parity-violating correlations are derived, and their magnitude in particular models is calculated. Further consequences of such a current are (i) a difference between l^--N and l^+-N cross sections and (ii) a deviation of the l^--N cross section from the form implied by one-photon exchange only. Tests for these effects are similarly examined, but an accurate knowledge of higher-order electromagnetic contributions to them is necessary before such tests can be implemented. (auth)

Strong (General)

Refer also to abstracts 16489 and 16793.

16670 (COO-3130-TA-286) HIGH-ENERGY MULTIPARTICLE MODELS. Kang, K. (Brown Univ., Providence, R. I. Dept. of Physics). 1973. Contract AT(11-1)-3130. 16p. (CONF-730337-1). Dep. NTIS $3.00.

Short-range and fragmentation models for multiparticle production in hadron-hadron interactions are discussed. It is found that neither model is truly successful. While the dominant mechanism is the short-range one, there appears to be a small diffractive component of low multiplicity shadowing the high multiplicity short-range component. (JFP)

16671 (JINR-D-6840, pp 57-71) HOW SIMILAR ARE REACTIONS WITH DIFFERENT MULTIPLICITIES OF FINAL STATES. Sosnowski, R. (Inst. for Nuclear Research, Warsaw). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

It is shown that the main features of two-body reactions are also characteristic of collisions with many secondary particles produced. The cross sections, secondary baryons in many-body reactions, and the distribution of the fastest particles in the cms are discussed. (JFP)

16672 (JINR-P2-7219) DUAL DIAGRAMS WITH ONE CLOSED LOOP. Popov, Kh. D.; Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1973. 15p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

An expression is found for the dual diagram with one closed loop and two excited particles with the help of an infinite set of 5-dimensional oscillators. Joining to the diagram two coherent states and using duality it is shown that the only contributions to the intermediate states in the dual diagram with one closed loop and N external particles come from those oscillators, which correspond to the external particles. (auth)

16673 TRIPLE-REGGE SCALING AND THE BEHAVIOR OF FORM FACTORS FOR RESONANCE COUPLINGS. Choudhury, S. R.; Mitra, A. N. (Department of Physics and Astrophysics, University of Delhi, Delhi-7, India). Phys. Rev. D 7: No. 5, 1541-1544 (1 Mar 1973).

The restrictions imposed by Feynman's scaling relation for single-particle spectra near the boundary of phase space are examined in relation to the production of a resonance of large mass Regge exchange in the sense of a Van Hove model. We obtain certain conditions on the form factor's coupling resonances of different spins. These are discussed in relation to the various form factors that have been used lately. (auth)

16674 DECAY OF A DIFFRACTIVELY EXCITED CLUSTER AND THE EXCLUSIVE COMPONENTS FOR INCLUSIVE REACTIONS. Lam, C. S. (Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, England). Phys. Rev. D 7: No. 5, 1481-1490 (1 Mar 1973).

In most of the recent diffractive-model calculations for inclusive reactions, the diffractively excited cluster is assumed to decay isotropically and no correlation is assumed to exist among the decay products. The importance of including at least the correlations due to energy-momentum conservation is emphasized, and the consequences for such an inclusion are analyzed. Very definite predictions are obtained for the multiplicity and momentum distributions coming from such a decay, and these should be compared with experiments in order to gain an understanding into the internal structure of excited hadrons. (auth)

16675 STUDY OF INCLUSIVE CROSS SECTIONS AND MULTIPLICITY DISTRIBUTIONS IN REGGE-POLE AND REGGE-CUT MODELS. Suranyi, Peter (Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221). Phys. Rev. D 7: No. 4, 1170-1184 (15 Feb 1973).

The properties of the multiplicity distribution and total inclusive cross sections are studied in models defined by the Regge-pole form or Regge pole plus infinitely many Regge cuts form of the generating function. Consequences of isospin invariance and charge-conjugation invariance are explored. The general form of the multiplicity distribution is given in the above models: A maximum at zero multiplicity and secondary maxima at $n=k<n>$, $k=2,3...$, are expected as a consequence of the existence of Regge cuts. The possibility of the extension of the results to (differential) inclusive cross sections is discussed. (auth)

16676 MANIFESTLY DUAL, "QUARKLIKE" OPERATOR FORMULATION OF A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Yu, Simon (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. D 7: No. 6, 1871-1879 (15 Mar 1973).

The N-point function of a dual resonance model with nonlinear trajectories is given in terms of a new operator formalism. The formalism gives factorized forms for different tree graphs related by duality. The structure of the operators resembles the quark diagrams of Harari and Rosner. (auth)

16677 IS A SUBTRACTION NECESSARY FOR THE PION MECHANICAL FORM FACTOR?. Dutt, Ranabir; Williams, P. G. (Department of Physics, Westfield College, University of London, London N. W. 3, England). Phys. Rev. D 7: No. 4, 1217-1220 (15 Feb 1973).

We investigate the consistency of ϵ and S^* dominance of the pion mechanical form factor with unsubtractedness, Ward identities, and s-wave $\pi\pi$ phenomenology. We conclude that the ϵ is not dominant as a result of the strong coupling of the S^* to both $\pi\pi$ and KK channels and an unsubtracted form factor is not ruled out in contrast to the conclusions of previous authors. (auth)

16678 DIMENSIONS AND EQUAL-TIME COMMUTATORS OF THE CURRENT COMPONENTS. Genz, H. (Max-Planck-Institut für Physik und Astrophysik, München,); Katz, J. Phys. Rev. D 7: No. 6, 1720-1725 (15 Mar 1973).

We make use of the usual assumption that the strong-interaction Hamiltonian density contains no parts with dimension larger than four to show that the a priori possibly different dimensions of the time and space components of any four-vector, in particular the currents, must in fact be the same. Furthermore, under slightly more restrictive, although conventional, assumptions on scale-symmetry breaking, it is shown that the usual equal-time commutators between the charges and the space components of the currents hold if and only if the equal-time Gell-Mann commutators between the charges and the components of the currents are satisfied. Moreover, the equal-time Gell-Mann commutator algebra of the time components of the currents implies that at most a first derivative of the δ function is contained in the equal-time commutators between their time and space components. The conventional symmetry property of the first-order Schwinger terms in these commutators furthermore follows. Incidentally, our results also imply that the local generalization of the σ terms does not contain any derivatives of the δ function. In deriving our results we have made no assumptions of the equal-time commutators of the Hamiltonian density and the currents. (auth)

16679 RELATIVISTIC EIKONAL APPROXIMATION AND VECTOR MESON EXCHANGE EFFECT. Doi, M.; Kotani, T. (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto); 49: No. 1, 242-255(Jan 1973).

The real part of the forward amplitude for high energy hadron-hadron elastic scattering is estimated from quantum field theory by means of a functional derivative method. If the generalized crossed ladder diagrams are taken into account, it is shown that the relativistic scattering amplitude can be treated in a way similar to the eikonal approximation of the nonrelativistic potential scattering. A massive vector meson is assumed to be exchanged between two colliding particles. Comparison with the p-p scattering data is discussed. (auth)

16680 SCALING RELATION FOR A QUANTITY RELATED TO PARTICLE PRODUCTION MULTIPLICITIES. Bander, Myron (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. Lett. 30: No. 10, 460-461 (5 Mar 1973).

A scaling relation, $d \ln[\sigma_n(s)]/d\ln s - p(n/\ln s)$, for high-energy production of n particles is proposed. This relation is supposed to be valid for large n and large s. An extension to present energies is suggested and compared with experiment. (auth)

16681 INCLUSIVE CROSS SECTIONS AT ULTRAHIGH ENERGIES. Yaes, Robert J. (Institut für Physik, Johannes Gutenberg Universität, 6500 Mainz, Germany). Phys. Rev. D 7: No. 7, 2161-2173 (1 Apr 1973).

We show that the representation of the inclusive cross sections, in terms of the "kinematically corrected" densities that we have previously obtained for the Fermi model, is also applicable to the uncorrelated jet model and to multiperipheral models in the fragmentation regions. In each case, the "corrected" density scales, and scaling is broken by the $\sigma(M^2)$ factor when M^2 becomes small. We discuss the properties of the "corrected" correlation functions and show that they are equal to the usual correlation functions in the central region and proportional to them in the second and fourth quadrants of the Van Hove hexagon. We obtain model-independent sum rules for the missing mass squared and an expression for its average value. We show that there must be a central peak in the longitudinal phase-space plots when the moments of multiplicity become large. (auth)

16682 FRAGMENTATION IN THE CENTRAL REGION: POSSIBILITY OF A DISCONTINUITY AT X=0. Hwa, Rudolph C.; Zucker, Paul A. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon). Phys. Rev. D 7: No. 7, 2148-2151 (1 Apr 1973).

The question of whether there may exist a discontinuity at x=0 in the pion spectrum of an inclusive reaction initiated by two unequal particles is raised. While such an occurrence is impossible in a model with only short-range correlations, it is a distinct possibility in the diffractive excitation model when the energy is high enough. We relate the discontinuity to the properties of the spectra of single diffractive excitations. Arguments are given as to why the discontinuity, if it exists, is not likely to be substantial. (auth)

16683 INCLUSIVE VECTOR-MESON PRODUCTION IN THE DUAL MODEL. Fenster, S.; Uretsky, J. L. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 7, 2143-2147 (1 Apr 1973).

The cross section for the process a+b→vector meson+anything in the central region at high energy is calculated in the dual resonance model. The model predicts that the total cross section for vector-meson production is down by about 10^{-3} from scalar-meson production at zero perpendicular momenta if the masses are those of the ρ-meson and pion. The vector meson is predicted to be polarized so that the decay "pions" tend to be emitted in the direction $\hat{p}_b$-$\hat{p}_b$ in the rest frame of the vector meson. Analytic approximations for the asymptotic dual amplitude, valid for all transverse momenta, are given for the first time. (auth)

16684 INCLUSIVE VECTOR-MESON PRODUCTION AT SMALL T IN THE DUAL RESONANCE MODEL. Randa, J. (Physics Department, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). Phys. Rev. D 7: No. 7, 2236-2248 (1 Apr 1973).

Starting from the B_8 of Chan and Tsou and using the results of DeTar, Kang, Tan, and Weis, we obtain expressions for the cross section and density-matrix elements of vector mesons produced in inclusive reactions. The behavior of these quantities as functions of energy, missing mass, and momentum transfer is explored. (auth)

16685 APPLICATIONS OF THE REGGEON CALCULUS TO DUAL MODELS. Tucker, R. W. (Univ. of Lancaster, Eng.). Nucl. Phys.; B58: No. 1, 157-177(1973).

The reggeon calculus devised by Polkinghorne to study the j-plane structure of hybrid graphs is utilized to investigate the orientable non-planar dual loop. A hybrid model with quark vertices is also studied and the calculus extended to deal with a dual reggeon triangle graph which contributes to the asymptotic behavior of a simple production process. Finally the results from single dual loops are expressed in terms of a reggeon operator calculus. (auth)

16686 QUARK MODELS AND THE POLARIZABILITY OF HADRONS. Schroeder, U. E. (Univ., Frankfurt am Main). Acta Phys. Austr.; 36: No. 3, 248-256(1972).

The polarizability of hadrons in an external electrostatic field is estimated by using integrally and fractionally charged quark models. The results obtained show that by a systematic study of the x-ray spectra emitted from hadronic atoms one may obtain valuable information on the structure of hadrons at low energies. (auth)

16687 RECALCULATION OF THE UNITARY SINGLE PLANAR DUAL LOOP IN THE CRITICAL DIMENSION OF SPACE-TIME. Brink, L.; Olive, D. (CERN, Geneva). Nucl. Phys., B58: No. 1, 237-253(1973).

The single planar dual-loop amplitudes are recalculated in the critical dimension of space time paying particular attention to the unitarity property by ensuring that the only states propagating internally in the loop are those needed to factorize tree diagram residues in a positive definite way. The two new technical features which make this possible are (i) our newly discovered physical state projection operator valid if the space-time dimension takes the critical value; (ii) the use of Feynman's tree theorem whereby it is sufficient to have the above projection operator on the mass shell. The final result agrees with a previous conjecture in that it differs from the original calculations with unprojected propagators by two inverse power of a certain partition function. The results apply to both the ordinary dual model and the Neveu-Schwarz model. (auth)

16688 BROKEN SCALE INVARIANCE. Kleinert, H. (Institut fuer Theoretische Physik, Berlin). Fortschr. Phys.; 21: No. 1, 1-55(1973).

By investigating the low energy properties of some hadron vertices some evidence is obtained for an approximate scale invariance of the world. A current is introduced generating certain scale transformations on local fields, whose divergence is dominated by the sigma meson. Ward identities are derived, parametrized in terms of particles, and relations are obtained for coupling constants involving the sigma meson. (JFP)

16689 HEURISTIC MODEL FOR FERMIONIC QUARKS HAVING WHOLE CHARGES. Cornec, A. (Univ., Paris). Compt. Rend., Ser. A, B; 276: No. 10, 347-350(5 Mar 1973). (In French).

The masses of quarks were determined using a 4 whole charge quark model based on D4 algebra. The magnetic moments of the particles of the octet are calculated. (auth)

16690 THE MULTIPERIPHERAL CLUSTER MODEL. Hamer, C. J. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. D 7: No. 9, 2723-2733 (1 May 1973).

A multiperipheral cluster model of high-energy inelastic collisions is discussed. A physical justification for the model is given, in that it accounts for "Ericson fluctuations" in the inelastic cross sections. These incoherent resonance contributions are ignored in most multi-Regge models. The major assumption is made that the ratio of the average fluctuation cross sections between different channels is governed by phase space. This allows a description of the cluster decay processes via the statistical bootstrap theory of Hagedorn and Frautschi. A simplified mathematical formulation of the model is studied, and it is shown that, subject to certain resistrictions on the vertex functions for cluster production, Feynman scaling occurs. The relationship with other models of inelastic processes is discussed. It is shown that the model includes both the ordinary multi-Regge model and the diffractive-excitation models of Hwa and of Jacob and Slansky, as limiting cases, and that the approach is equivalent to, but is a refinement on, Hagedorn's thermodynamic model. A search for a power-behaved "tail" in the multiplicity distributions at high energies would provide an important test of the model. (auth)

16691 COMMENTS ON KINEMATIC MODELS OF INCLUSIVE SPECTRA. Campbell, David K. (The Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 9, 2793-2799 (1 May 1973).

To clarify the nature of kinematic constraints in inclusive processes we examine in critical detail the inclusive spectra in "phase space" or "uncorrelated jet" models (UJM). In particular, we study the manner in which these spectra satisfy the general inclusive energy-momentum sum rules. Among other results we find: (1) Although the standard approximation techniques used to treat the UJM yield a total inclusive rate which differs slightly from the exact asymptotic result, this difference does not affect the normalized inclusive spectra. (2) The two-particle longitudinal correlations are vanishingly small in the central region. In gas-analogy terms, the particles are correlated only through the "walls" of the container. (3) The transverse-momentum sum rules are satisfied in the UJM in a manner quite different from that in a short-range model. (auth)

16692 COMMENT ON COUPLINGS OF A POMERANCHUK CUT. Sivers, Dennis (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 9, 2790-2792 (1 May 1973).

We examine the asymptotic behavior of an inclusive cross section in the triple-Regge region implied by the existence of a leading J-plane branch point. We find a relation between the coupling and the hardness of the discontinuity across the branch cut. In particular, if the discontinuity is soft, the coupling analogous to the triple-Pomeranchuk vertex need not vanish at t=0. (auth)

16693 COMMENTS ON CHARGE DISTRIBUTION IN MULTIPION PRODUCTION. Chacón, E.; Moshinsky, M. (Instituto de Física, Universidad de México, México, D.F., México). Phys. Rev. D 7: No. 9, 2783-2788 (1 May 1973).

Pais and collaborators determined the expectation value of the number of positive, neutral, and negative pions for N-pion states corresponding to a given irreducible representation (IR) of the permutation group S(N), when the isospin is 0 or 1. In this comment we indicate how the problem can be reduced to the expectation value of the quadrupole moment for states characterized by IR's of the unitary group U(3) and its orthogonal subgroup O(3). The latter expectation value was determined by Elliott for any IR of O(3) that appears only once in the

given IR of U(3). As the partitions characterizing the IR of U(3) and S(N) are the same and the IR of O(3) corresponds to the isospin, a generalization of Pais's results follows from Elliott's analysis. (auth)

16694 MULTIPICITY DISTRIBUTIONS RESULTING FROM MULTIPERIPHERAL PLUS DIFFRACTIVE PRODUCTION. Frazer, William R. (Department of Physics, University of California, San Diego, La Jolla, California 92037); Peccei, Roberto D.; Pinsky, Stephen S.; Tan, Chung-I. Phys. Rev. D 7: No. 9, 2647-2658 (1 May 1973).

We discuss the phenomenology of multiplicity distributions in high-energy hadronic collisions in terms of the short-range correlation picture, modified to include diffractive processes leading to low-multiplicity final states. We formulate two models, both of which give reasonable fits to present data on high-energy partial cross sections. Model-independent methods for separating diffractive and multiperipheral production are discussed. (auth)

16695 CHARGE TRANSFER IN A MULTIPERIPHERAL PICTURE. Quigg, C. (National Accelerator Laboratory, Batavia, Illinois 60510); Thomas, G. H. Phys. Rev. D 7: No. 9, 2752-2755 (1 May 1973).

The transfer of charge from one c.m. hemisphere to the other is discussed in terms of schematic multiperipheral models. The results expectations for experimental quantities contrast markedly with predictions based on the fragmentation picture. Particularly sensitive tests between the rival viewpoints are indicated. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 16790.

16696 (NP-19802) RADIAL EXCITATIONS AND THE ρ'. Raitio, R.; Roos, M. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1973. 10p. Dep. NTIS (U. S. Sales Only) $3.00.

Using quark-model arguments for the photon-vector meson coupling the $\rho'(1600)$ meson is interpreted as a radial $q\bar{q}$ excitation. The absence of $\pi\pi$ decays is explained by a selection rule for radial de-excitations, applicable also to the $P_{11}(1470)$ baryon state with similar dynamics. The scheme parallels a recent consideration of scale invariance breaking. (auth)

16697 SINGLE-LOOP CALCULATIONS WITH THE CHIRAL-INVARIANT PION LAGRANGIAN. Allen, L.; Willey, R. S. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). Phys. Rev. D 7: No. 6, 1825-1829 (15 Mar 1973).

In the one-loop approximation to the chiral-invariant pion theory, it is shown that the unrenormalized on-shell $\pi\pi$ scattering amplitude depends on the choice of pion field, while the renormalized amplitude does not. By elementary calculation it is verified that only one arbitrary subtraction constant, in addition to conventional renormalization, is required. (auth)

16698 GAUGE MODEL OF VECTOR-MESON MASSES. Georgi, Howard (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 7: No. 4, 1258-1260 (15 Feb 1973).

We construct a model of the strong interactions with spontaneously broken U(3) $\times$U(3) gauge symmetry based on the ideas of Bardakci and Halpern and interpret the gauge bosons as the observed strongly interacting vector mesons. We assume that global SU(3) is broken only by terms of dimensions less than four in the Lagrangian. The model that arises is a trivial generalization of the "strong" part of the Bars-Halpern-Yoshimura model. This leads to a well-satisfied relation among the π, K^*, A_1, K_A, ω, and ϕ masses. (auth)

16699 S, P, AND D WAVES IN A $\pi\pi$-SYSTEM WITH CDD-POLES. Lang, C. B.; Urban, P. (Univ., Graz). Acta Phys. Austr.; 36: No. 2, 137-157(1972).

Warnock's N/D-system is solved numerically for pion-pion S, P and D partial waves under the assumption of CDD-poles placed at infinity. Correct ρ and f^0 resonance widths and self-consistent crossing-symmetric S waves with an ϵ-resonance, although the corresponding "down-type" phase shift does not pass through 90°, are found. (auth)

16700 DUALITY IN $\pi\rho \to \pi\rho$. Haut, H. (Univ., Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. I; 87: No. 2, 237-249(1973). (In French).

The location of zeroes of the helicity amplitudes in the charge exchange $\pi\rho$ processes is studied. It is shown that a solution compatible with semi-local duality exists. (auth)

16701 ZEROS OF THE VECTOR-MESON PRODUCTION AMPLITUDE AND THEIR IMPLICATIONS. Gutay, L. J.; McIlwain, R. L. (Department of Physics, Purdue University, West Lafayette, Indiana 47907); Vasavada, K. V.; Meiere, F. T. Phys. Rev. Lett. 30: No. 10, 465-468 (5 Mar 1973).

In studying the single-pion production amplitudes in the vector-meson mass range (ρ and K^*) we observed zeros and structures in $\mathrm{Re}\rho^{\{1\}}_{\{0\}}$ and $\rho^{\{1\}}_{\{1\}}$ density matrix elements. The zero of $\mathrm{Re}\rho^{\{1\}}_{\{0\}}$ is observed to be approximately independent of beam momentum, charge state, or strangeness of vector meson and is invariant under s-t crossing at $\Delta^2 \simeq m_\nu^2 - m_{ps}^2$. This gives a strong support to absorptive models. Our analysis shows inconsistencies in the recent amplitude analysis. (auth)

16702 CONTINUATION OF ZERO CONTOURS FROM WEINBERG'S LOW-ENERGY $\pi\pi$ MODEL TO THE ρ REGION. Pennington, M. R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Schmid, C. Phys. Rev. D 7: No. 7, 2213-2219 (1 Apr 1973).

We assume that the subthreshold zeros of Weinberg's $\pi\pi$ scattering amplitude smoothly continue into the physical region to become the Legendre zero of the ρ resonance. We show that this hypothesis of smooth zero contours is justified in the channel $\pi^+\pi^0 - \pi^+\pi^0$. This enables us to give a new derivation of the Kawarabayashi-Suzuki-Riazuddin-Fayyazuddin relation and to predict the I = 2 s wave correctly. (auth)

16703 DECAY $\eta' \to \eta\pi\pi$ AS A TEST OF CHIRAL SYMMETRY BREAKING. Genz, H. (Institut für Theoretische Kernphysik der Universität Karlsruhe, Karlsruhe, Germany); Katz, J.; Steiner, H. Phys. Rev. D 7: No. 7, 2100-2105 (1 Apr 1973).

The width Γ of the decay $\eta' \to \eta\pi\pi$ is estimated in the (8,8) model of chiral symmetry breaking. Under plausible additional assumptions we find $\Gamma > 0.27$ MeV together with an experimentally uninteresting upper limit. In particular, the (8,8) model is—at least under present extrapolation errors in the Dalitz plot of the decay—consistent with any Γ above our lower limit and below the experimental upper limit $\Gamma < 2.7$ MeV. The actual width may be expected to be around 1 MeV in perfect agreement with the (8,8) model. Our assumptions include that the dimension l_u of the chiral-symmetry-breaking Hamiltonian density has the particularly attractive value 2. For this value, the convention $(3,\bar{3}) \oplus (\bar{3},3)$ model predicts for $\Gamma < 0.065$ MeV. Despite the large extrapolation errors the decay $\eta' \to \eta\pi\pi$ therefore clearly distinguishes between the two models and might be decisive. For any given extrapolation the estimated Γ of the (8,8,) model is at least 13 times bigger than the prediction of the $(3,\bar{3}) \oplus (\bar{3},3)$ model for $l_u = 2$. For $l_u = 3$ a prediction can be obtained in the $(3,\bar{3}) \oplus (\bar{3},3)$ model with a c-number δ. It reads $\Gamma < 0.25$ MeV and is roughly compatible with the expected width. The η' (958) is taken to be a possible ninth pseudoscalar meson throughout. It is however emphasized that nonexistence of an SU(3) scalar meson might be a plausible alternative in the (8,8) model. (auth)

16704 DUALITY, THE GENERALIZED POTENTIAL, AND FAILURE OF THE ρ BOOTSTRAP. Shaw, Gordon L. (International Centre for Theoretical Physics, Trieste, Italy.). Phys. Rev. D 7: No. 7, 2265-2266 (1 Apr 1973).

A model, explicitly consistent with duality, is obtained for the generalized potential term B(s) in the partial-wave dispersion relation. We then observe that for the elastic I=1 $\pi\pi$ amplitudes, B(s) =0 (except for the breaking of ρ-f^0 exchange degeneracy). Thus the classic N/D dynamical calculations of the ρ meson using elastic unitarity must fail in this model. (auth)

16705 EXPERIMENTAL TESTS FOR EXOTIC STATES IN THE BARYON-ANTIBARYON SYSTEM. Lipkin, Harry J. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 7, 2262-2265 (1 Apr 1973).

New experiments are proposed in which negative as well as positive results are significant. A new finite-energy sum rule based on dominance of ρ and ω exchange for high-energy odd-signature amplitudes gives quantitative estimates for production of doubly charged exotic meson resonances via Δ exchange in nucleon-antinucleon and pion-nucleon reactions. Absence of exotic resonances with predicted cross sections would indicate serious disagreement with two-component duality. (auth)

16706 A_1 AND ρ MESONS FROM THE VIOLATION OF LOCAL LORENTZ INVARIANCE. Hayashi, K. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 4B: No. 6, 497-501(11 Jun 1973).

A skew-symmetric field and its dual field are quantized by requiring Lorentz invariance and the positive definiteness of the Hamiltonian. When they are massless, they describe scalar and pseudoscalar particles, respectively, i.e., $h^{PC} = 0^{++}$ and 0^{--} (h denotes helicity). If they acquire their mass, then they become axial vector ($J^{PC} = 1^{++}$, like the A_1 meson) and vector ($J^{PC} = 1^{--}$, like the ρ meson), respectively. The lowest-order Lagrangian may be derived from a generally covariant Lagrangian for the gravitational field, previously proposed. (auth)

16707 SINGLE PARTICLE DISTRIBUTIONS FROM VENEZIANO AMPLITUDES. II. Bebel, D.; Biebl, K. J.; Ebert, D.; Otto, H. J. (Humbolt-Univ., Berlin). Fortschr. Phys.; 20: No. 9, 555-569(1972).

The x- and $p_\perp^2$-dependence of the distribution function for the inclusive reaction A + B → C + anything was investigated for some typical cases using the dual six point function in the tree approximation as a model for T_{33}. It is found that the form of the x-distribution depends critically on the trajectory intercepts in the $A\bar{C}$ and $B\bar{C}$ channels, respectively. The $p_\perp^2$-dependence is nearly exponential for large x. For small x-values a steeper behavior in the small $p_\perp^2$-region is obtained which is especially pronounced for small masses of the observed particles. Diagrams with twists contributing to the distribution function for inclusive reactions with neutral pions lead to oscillations and dips near the nonsense wrong signature points of the $A\bar{C}$ and $B\bar{C}$ channel trajectories. (auth)

16708 CHARGED ρ-MESON PHOTOPRODUCTION ON NUCLEI. Gevorkyan, S. R. (Erevan Inst. of Physics). Izv. Akad. Arm. SSR, Ser. Fiz.; 7: No. 5, 320-323(1972). (In Russian).

In the framework of incoherent production theory of Glauber–Margolis valid for a wide range of t momentum transfer, the cross section of charged ρ-meson photoproduction on nuclei was obtained for $E_\gamma \leq 3$ GeV. The dependence of these cross sections on the atomic number is presented. (auth)

16709 DUALITY IN $\pi\rho \rightarrow \pi\rho$. Haut, H. (Univ., Louvain, Belgium). Ann. Soc. Sci. Brux. Ser. I; 87: No. 2, 237-249(15 Jun 1973). (In French).

The location of zeroes of the helicity amplitudes in the charge exchange $\pi\rho$ processes is studied. It is shown that a solution compatible with semi-local duality exists. (auth)

16710 TWO-VARIABLE EXPANSIONS AND $\bar{p}n \rightarrow 3\pi$ ANNIHILATIONS AT REST. Hicks, H. R. (Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213); Shukre, C.; Winternitz, P. Phys. Rev. D 7: No. 9, 2659-2667 (1 May 1973).

The experimental Dalitz plot for $\bar{p}n \rightarrow \pi^+\pi^-\pi^-$ annihilations at rest is analyzed, using previously suggested two-variable expansions of decay amplitudes, based on the representation theory of the group O(4). A fair fit to the Dalitz plot is obtained by minimizing the χ^2 function, assuming that the annihilation proceeds from a protium state of definite (but unspecified) angular momentum J (or from several such states). Fits with 2, 4, 6, and 9 free parameters are considered, the values of the parameters are essentially stable with respect to the "cutoff" of the expansion, and the solutions are unique. The fit is purely kinematical, in that no assumptions are made about the initial and final state or the annihilation dynamics. An analysis of the contribution of various parts of the Dalitz plot to the over-all χ^2 suggests that the fit would be considerably improved by including e.g. ρ- and f-meson final-state resonances explicitly. We compare the O(4) expansions with a power-series expansion in Dalitz-Fabri variables and also with various models that have been recently applied, in particular the Veneziano model and its generalizations and various final-state-interaction models. (auth)

16711 HOW ROY'S EQUATIONS RESOLVE THE UP-DOWN AMBIGUITY AND REPRODUCE THE S* RESONANCE. Pennington, M. R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720); Protopopescu, S. D. Phys. Rev. D 7: No. 9, 2591-2596 (1 May 1973).

By making simple Regge-pole and resonance estimates of the high-energy and intermediate-energy $\pi\pi$ scattering amplitude and using recent $\pi\pi$ experimental data, we are able to show that both the rapid rise of the I = 0 s-wave phase shift near the $K\bar{K}$ threshold and the consequent resolution of the up-down ambiguity are consistent with the rigorous equations of Roy. (auth)

16712 CHIRAL SU(2) ×SU(2) SYMMETRY IN THE πK SCATTERING. Kang, J. S. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790). Phys. Rev. D 7: No. 9, 2636-2647 (1 May 1973).

The chiral SU(2) ×SU(2) symmetry is studied for the πK scattering in the scheme of the linear realization. Roskies-type relations are used for the crossing symmetry, and the relativistic version of the effective-range approximation is imposed on for unitarity. Two alternatives of the up-down ambiguity for the I= (1/2), 0⁺ resonance are investigated, and our analysis favors the up-solution with κ (870). The σ term in the πK scattering is estimated to be about −1.1 m_π^2. This is another measure of the chiral SU(2) ×SU(2) breaking and is consistent with other features of the symmetry breaking. Finally the threshold effect on the K_{l3} form factor is studied and compared with experiment. (auth)

16713 SCALING IN HADRONIC COLLISIONS AND THE NEW KINEMATIC VARIABLE n^2. Leader, E. (Department of Physics, Westfield College, University of London, London NW3, United Kingdom); Pennington, M. R. Phys. Rev. D 7: No. 9, 2668-2690 (1 May 1973).

We present the underlying theoretical motivation for the recently introduced kinematic variable n^2. Scattering amplitudes are considered as functions of s and n^2, and asymptotic formulas for $s \rightarrow \infty$ at fixed n^2 are derived. It is shown empirically that many diffractive reactions appear to scale, i.e., they show little or no energy dependence when considered as functions of n^2. The shrinkage of the forward diffraction peak in $d\sigma/dt$ seen in many reactions at present energies, is predicted to die out with increasing energy. It is shown that $pp-\bar{p}p$ scattering should exhibit antishrinkage. Several reactions are studied: $pp \rightarrow pp$, $K^+p \rightarrow K^+p$, $\pi^\pm p \rightarrow \pi^\pm p$, $\gamma p \rightarrow \rho p$, $\gamma p \rightarrow \phi p$, $pp \rightarrow pN^*$. Speculative predictions are made for a kind of "superscaling" in inclusive reactions and in deep-inelastic electron scattering. (auth)

16714 OPTIMAL BOUNDS ON CROSS-SECTION MOMENTS IN π–π AND π–N SCATTERING. Steven, Alasdair C. (Cavendish Laboratory, University of Cambridge, Cambridge, England). Phys. Rev. D 7: No. 9, 2709-2717 (1 May 1973).

Froissart-like bounds are derived for a selection of moments of the total cross section in π–π and π–N scattering. These bounds stem from an economical set of constraints—unitarity and the Froissart-Gribov representation of the D-wave scattering length in the crossed channel a^1_2—which are rigorous to within the value assigned to this scattering length. The results are optimally tight for the given constraints and represent a substantial improvement on the bounds of Yndurain and Common, from whose work this paper has been developed. In the case of π–N scattering, it is possible to invert the argument by using experimental data on total cross sections to impose a lower bound on a^1_2. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 16560 and 17075.

16715 (CEA-N-1601) REGGE ANALYSES OF THE FORWARD SCATTERING, IN THE REACTIONS $0^- \frac{1}{2}^+ \rightarrow 0^- \frac{1}{2}^+$ AT HIGH ENERGY. Derem, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1973. 161p. (In French). Dep. NTIS (U. S. Sales Only) $10.25.

Thesis. Submitted to Paris Univ. (France).

Two-body π-nucleon and K-nucleon reactions ($0^- \frac{1}{2}^+ \rightarrow 0^- \frac{1}{2}^+$) are analyzed above 4 GeV/c, using the Regge representation for the asymptotic amplitude. The study is limited to forward scattering for $t < = 1$ GeV^2. The structure of the invariant amplitudes A' and B, for the P, P', ω, ρ, A2, K*(890) and $K_N(1420)$ exchange is determined. This study is carried out in the framework of exact SU(3) symmetry. (auth)

16716 (ITEF-854) EXPERIMENTAL MULTINUCLEON RESONANCE STUDY. Leksin, G. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 28p. (In Russian). INIS.

Published material on the cross sections of dibaryon processes interpretable as resonances was reviewed. The energy dependence of: total scattering cross sections, the total cross section of one of the possible channels, and of the differential cross section of a channel, were investigated. The dependence of a number of cases of reaction on the invariant mass of the system was studied. Experiments for determining the spin and parity of possible dibaryons are discussed. The isonucleus hypothesis was strengthened by peculiarities of a many-baryon system. (tr-auth)

16717 (JINR-D-6840, pp 72-79) DETERMINATION OF RESONANCE PRODUCTION CROSS SECTIONS FOR THE REACTION $\pi^-p \rightarrow \pi^-\pi^+n$ AT 5 GeV/c. Glagolev, V. V., Gramenitskii, I. M.; Korzhavina, I. A.; Lebedev, R. M.; Lednitski, R.; Nioradze, M. S.; Rud, V. I.; Saitov, I. S.; Tikhonova, L. A.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16718 (JINR-D-6840, pp 263-269) INCLUSIVE γ SPECTRA FROM THE THERMODYNAMIC MODEL. Kripfganz, J.; Mueller, V.; Ranft, G.; Ranft, J.; Blutner, R.; Than, H. (Karl-Marx-Univ., Leipzig). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

Gamma production in hadron–hadron collisions proceeds mostly via the decay of neutral π mesons. Inclusive π^0 spectra are calculated from the thermodynamic model for pp and πp collisions. The γ spectra are obtained from the π^0 spectra by kinematics only. The inclusive γ spectra $pp \rightarrow \gamma$ + anything in the central region are compared with ISR data. The deviations from scaling predicted by the model agree with the deviations found experimentally. In the central region equal numbers of π^+, π^-, and π^0 are produced at ISR energies. (auth)

16719 (JINR-D-6840, pp 288-297) SPIN–PARITY INVESTIGATIONS ON 3π SYSTEMS. Nowak, S.; Nowak, W. D. (Institut fuer Hochenergiephysik, Zeuthen, Ger.). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

A method for spin-parity determination of the charged three pion system in the reaction $\pi^{\pm}p \rightarrow p\pi^{+}\pi^{\pm}\pi^{-}$ is described. Studying the quality of the Dalitz-plot method used by means of simulated events an anomaly is found for the $J^P = 2^+$ state. (auth)

16720 (JINR-D-6840, pp 309-318) STABLE REPRESENTATION OF DATA BY ANALYTIC FUNCTIONS. Presnajder, P. (Katedra Teoretickej Fyziky PF UK, Bratislava). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The statistical approach is considered. The idea is to consider a suitable space of functions and to introduce the probability into this space. The probability is directly given by the data and by the corresponding experimental errors. The applications are given for the coupling constant and sigma term in pion–nucleon scattering and to the KN coupling constant. (JFP)

16721 (JINR-D-6840, pp 319-323) DETERMINATION OF THE PION–NUCLEON COUPLING CONSTANT BY ANALYTIC EXTRAPOLATION. Lichard, P. (Technical Univ., Bratislava). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The use of the analytic extrapolation method is illustrated using the calculation of the pion–nucleon coupling constant. The pion–nucleon charge-exchange forward scattering amplitude is considered. (JFP)

16722 (JINR-D-6840, pp 324-330) METHOD TO DETERMINE SINGULARITIES OF SCATTERING AMPLITUDES. Nogova, A.; Pisut, J. 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The determination of resonance parameters from experimental data on partial waves is discussed for the $\Delta(1236)$ resonance in pion–nucleon scattering. (JFP)

16723 (JINR-D-6840, pp 331-339) MODEL FOR STRONGLY INTERACTING PARTICLES AT LOW AND INTERMEDIATE ENERGIES. Blazek, M. (Inst. of Physics, Bratislava). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

Relativistic partial wave amplitudes are continued on unphysical sheets by means of the two-particle unitarity. Dispersion relations including the contributions from all sheets are used for computation of the physical phase shifts. The location of the force cuts is determined by means of the effective mass and the effective width of the resonances (or of the ensemble exchanged) where the experimental form of the resonance might be taken into account (without introducing new free parameters). The objects exchanged might be considered as composed of parts whose energy distribution is determined by means of the statistical laws. If that distribution function is interpreted as the discontinuity across the corresponding force cut, characterizing the "radiation" of the exchanged object, then the convergent integrals are obtained. Introducing the coupling constants by means of the normalization of the discontinuities, only the mass and the width of the objects involved enter as the free parameters in the present procedure. In the aforementioned approach there are not met the difficulties connected with the necessity of the continuation of the partial wave amplitudes into the areas of the complex energy plane where the denominators varish (occurring in the inelastic cases). (auth)

16724 (JINR-D-6840, pp 340-351) SOME PROBLEMS AND NEW RESULTS FOR THE STATIC LIMIT IN DISPERSION RELATIONS. Zhuravlev, V. I.; Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16725 (JINR-E2-7159) SPIN STRUCTURE OF THE INTERACTION OF TWO RELATIVISTIC PARTICLES IN ONE-MESON EXCHANGE MODEL. Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1973. 35p. Dep. NTIS (U. S. Sales Only) $3.75.

In quasipotential equation for particles with spin the Feynman matrix elements, corresponding to diagrams of one-boson exchange, are taken as quasipotential. It is shown that after separation of the Wigner rotation from these matrix elements the remaining part is local in the sense of Lobachevsky geometry. With the help of the obtained representation the quasipotential equation is transformed to a form in which the spin structure of the interaction looks like direct geometrical relativistic generalization (in sense of exchange of the Euclidean geometry for the Lobachevsky one) of the spin structure of the potential in quantum mechanics. (auth)

16726 (RL-73-31) πN AMPLITUDES AT LARGE MOMENTUM TRANSFER. Elvekjaer, F.; Inami, T.; Phillips, R. J. N. (Rutherford High Energy Lab., Chilton (England)). May 1973. 25p. Dep. NTIS (U. S. Sales Only) $3.25.

The πN amplitudes are estimated from data in the region $0.8 \leq |t| \leq 1.4$ (GeV/c)^2 for incident momentum between 3.7 and 14 GeV/c, under the assumption of ρ-Regge-pole phase for the $I_t = 1$ s-channel helicity flip amplitude. The main conclusions are: The real part of the $I_t = 0$ nonflip amplitude is substantial and its nonasymptotic variation with energy has not died out. The $I_t = 1$ nonflip amplitude shows a large degree of shrinkage as energy increases out to $t = -1.4$ (GeV/c)^2. The $I_t = 1$ nonflip amplitude has a second cross-over zero at $t \simeq -1.2$ (GeV/c)^2 in its imaginary part. (auth)

16727 T-CHANNEL UNITARITY AND THE πN σ TERM. Geddes, H. B.; Graham, R. H. (Department of Physics, University of Toronto, Toronto, Canada). Phys. Rev. D 7: No. 6, 1801-1806 (15 Mar 1973).

We unitarize the low-energy symmetric πN amplitude introduced by Altarelli et al. under the assumption that the 2π intermediate state in the t-channel unitarity condition is the dominant contribution. The low-energy $\pi\pi$ amplitude is described using a model of Graham and Johnson. The unitarity corrections at the current-algebra point are found to be small. Hence, considerations of t-channel analyticity probably do not seriously affect the calculation by Cheng and Dashen of the πN σ term. (auth)

16728 PHENOMENOLOGICAL ANALYSES OF ELASTIC SCATTERING AT HIGH ENERGY. Geer, K. A. Madison, WI; Univ. of Wisconsin (1972). 299p. University Microfilms Order No. 73-2541.

Thesis (Ph. D.).

The structures of the Pomeron vector and tensor meson exchange contributions to the imaginary spin nonflip elastic scattering amplitudes are investigated. The imaginary helicity nonflip ω exchange amplitudes in KN and NN scattering are determined versus t and s from data on elastic differential cross section differences. The ω universality prediction $\mathrm{Im}\omega_N(t) = 3\mathrm{Im}\omega_K(t)$ is found to be satisfied for $0 \leq |t| \leq 0.5$, indicating that the absorptive cuts at small t preserve universality. The impact parameter distributions of the ω amplitudes show: (1) a peripheral peak centered around $b \simeq 1$ Fermi, with $\Delta b \simeq \pm 0.5$ F in KN and $\Delta b \simeq \pm 0.75$ F in NN, (2) a sizeable negative contribution at small b, more negative in NN than in KN, (3) a smaller tail of negative contributions around $b \simeq 2$ Fermis. Strong absorption of the ω pole imaginary amplitude with λ values around two is needed to reproduce this structure. The energy dependences of $\pi^{\pm}p$, $K^{\pm}p$, pp, and $\bar{p}p$ elastic scattering data in the 3 to 30 GeV range are represented by effective trajectories. A simple power law dependence is found to be possible for all reactions but pp, which exhibits a break in energy dependence at 8 GeV. A pure Pomeron interpretation of K^+p and pp requires a Pomeron trajectory slope $\alpha'_P \simeq 0.7$, in disagreement with recent determinations from $\gamma p \rightarrow \phi p$ and pp ISR experiments. For Pomeron trajectory slopes in the range $0 < \alpha'_P < 1$, the imaginary part of the f nonflip exchange amplitude is calculated from cross section sums $[d\sigma/dt\,(\bar{A}B) + d\sigma/dt\,(AB)]$. The structure of the f residue is dependent on the value of α'_P. For $\alpha'_P < 0.4$ the f amplitude is definitely nonperipheral whereas for $\alpha'_P \approx \alpha'_f \approx 1$ it is peripheral. On the basis of the overall evidence on other tensor exchanges and on the Pomeron trajectory slope one concludes that the dual absorption model fails to describe the nonperipheral structure of tensor exchange amplitudes. Implications of the new CERN Intersecting Storage Rings pp elastic scattering data are considered. It is shown that a peripheral component of the Pomeron, with radius 1.2 Fermi, gives a quantitative explanation of the break at $t = -0.1$ found in the pp elastic slope parameter b(pp) in Intersecting Storage Ring experiments. The energy dependence of b(pp) above 200 GeV is accounted for by a Pomeron trajectory with slope $\alpha'_P \approx 0.2$. The effects of f and ω exchanges are significant in b(pp) below 200 GeV, and in $b(\bar{p}p)$ up through ISR energies. A simple explicit model is constructed that fits pp and $p\bar{p}$ σ_T and $d\sigma/dt$ data above 20 GeV, and accounts for the $\Delta b(pp) \approx 1.5$ rule of the pp slope break at all energies. (Diss. Abstr. Int., B)

16729 PARITY-VIOLATING π–N–N INTERACTION AND THE REACTION $\pi^-p \rightarrow n\gamma$. Keliher, T. E. Seattle; Univ. of Washington (1972). 167p. University Microfilms Order No. 73-13,842.

Thesis (Ph. D.).

A new contribution to the π–N–N parity-violating vertex is considered. Previous arguments from CP invariance have shown that if the nucleons are on-mass shell there can only be contributions to a π–N–N parity-violating vertex from strangeness-changing weak currents. The magnitude of this contribution is 4×10^{-8}. To

obtain a nonzero contribution for strangeness-conserving currents it is necessary to use a model that allows a strong renormalization of the weak pion-nucleon vertex. The model chosen is the σ-model which preserves PCAC and chiral invariance. It is found that there are contributions to $\pi^{\pm}-N-N$ parity-violating vertex if one or both nucleons are off-mass shell. The magnitude for this vertex for charged pions is roughly 8×10^{-6} for one nucleon off-mass shell by the pion mass. It is also predicted that there is a π^0-N-N vertex of roughly the same magnitude. The reaction $\pi^-\rho \rightarrow n\gamma$ with the pion and the proton at rest is considered as a test of the above model. Any parity-violating will lead to a circular polarization of the photon. For the strangeness changing current contribution, the circular polarization is found to be $\simeq 10^{-8}$. For the strangeness-conserving currents the circular polarization calculation is carried out in two ways, essentially depending on which diagrams are included. Certain diagrams that could be used to define an effective pion-nucleon vertex (diagrams where the photon does not become involved with the renormalization of the weak pion vertex) lead to a circular polarization of 1×10^{-6}. Including all possible diagrams, a circular polarization of 3×10^{-6} is found. This result indicates for certain problems, where an order of magnitude answer is desired, that it may be possible to use an effective parity-violating pion-nucleon vertex and not become involved with the calculations of more complicated diagrams. (Diss. Abstr. Int., B)

16730 HELICITY CONSERVATION FOR PION–NUCLEON SCATTERING IN THE BRICK–WALL COORDINATE SYSTEM. Thews, R. L. (Department of Physics, University of Arizona, Tucson, Arizona 85721). Phys. Rev. D 7: No. 5, 1549-1553 (1 Mar 1973).

It is shown that present data on πN elastic scattering are consistent with asymptotic (with energy) helicity conservation in the nucleon brick-wall coordinate system. (auth)

16731 ROLE OF DIFFRACTIVE EXCITATION MECHANISM IN MULTIPLE PRODUCTION OF HADRONS. Uehara, M. (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 49: No. 1, 227-241(Jan 1973).

The role of diffractive excitation mechanism is examined; the rate of total diffractive cross section is estimated to be about ⅓, at most, of the total inelastic πN cross section at 16 GeV/c. A large non-diffractive production mechanism is needed. Behavior of the average multiplicity and its dispersion are discussed in the case that the diffractive and non-diffractive mechanism coexist. A simple model with a pomeron as a fixed pole is given, which is normalized absolutely so that it reproduces experimental low mass spectra approximately. A single pion distribution function is also discussed. (auth)

16732 A PARAMETER–FREE REGGEIZED ABSORPTION MODEL FOR MESON–BARYON SCATTERING. Adjei, S. A.; Collins, P. A.; Hartley, B. J.; Moriarty, K. J. M. (Department of Physics, Imperial Westfield College, London SW3); Moore, R. W. Ann. Phys. (N.Y.) 75: No. 2, 405-460 (Feb 1973).

A Reggeized absorption model containing no free parameters to be fitted to the data being explained is applied to a wide range of meson–baryon scattering reactions. This model incorporates U(6, 6) ⊗O(3, 1) symmetry and strong exchange degeneracy in the pole–graph amplitudes. The agreement between the theoretical predictions and the experimental data on differential cross sections, polarizations and spin density matrix is extremely encouraging. (auth)

16733 IMPLICATIONS OF MISSING–MASS EXPERIMENTS FOR REGGE CUTS. Bishari, Mordechai (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. D 7: No. 7, 2106-2110 (1 Apr 1973).

The impact of the empirical features of missing–mass spectra on Regge cuts is studied. The measured processes $a+p \rightarrow X+p$ ($a=\pi^-$,p) indicate a large diffractive component in certain Reggeon–particle amplitudes which may crucially affect the structure of the corresponding cuts. This diffractive term essentially measures the possible deviation from results for cuts derived in models with resonances only, such as the Finkelstein selection rules which are based on duality–diagrams considerations. Additional results for cuts are pointed out from the observed weak coupling of the Pomeranchon to large masses. (auth)

16734 REGGE PHENOMENOLOGY OF TWO–PARTICLE INCLUSIVE PROCESSES. Brower, Richard C. (Lauritsen Laboratory of Physics, California Institute of Technology, Pasadena, California 91109); Cahn, Robert N.; Ellis, John. Phys. Rev. D 7: No. 7, 2080-2092 (1 Apr 1973).

Using the Regge analysis of Mueller and assuming factorization we calculate the leading meson Regge corrections to scaling in several two–particle inclusive processes, $a+b \rightarrow c+d+X$. We consider the limit where c is a fragment of a, and d is a fragment of b, denoted by $(a \rightarrow c|d \rightarrow b)$. Inclusive Reggeon vertices are extracted from one–particle inclusive data, using exchange–degeneracy assumptions motivated by experiment and conservative theoretical prejudices about early scaling. These vertices are then combined (i) to predict that the following processes should scale early: $(p \rightarrow \pi^-|\pi^- \leftarrow \pi^+)$, $(p \rightarrow \pi^-|\pi^+ \leftarrow p)$, $(p \rightarrow \pi^{\pm}|\pi^{\pm} \leftarrow p)$, and $(p \rightarrow \pi^{\pm}|\pi^- \leftarrow K^+)$ (ii) to predict large Regge corrections to scaling in the processes $(p \rightarrow \pi^-|\pi^+ \leftarrow \bar{p})$ and $(p \rightarrow \pi^-|\pi^+ \leftarrow K^-)$; and (iii) to make qualitative predictions about other inclusive processes. Comparisons with experiment agree with the predictions for $(p \rightarrow \pi^-|\pi^- \leftarrow p)$, $(p \rightarrow \pi^-|\pi^- \leftarrow K^+)$, and $(p \rightarrow \pi^-|\pi^+ \leftarrow K^-)$, and are consistent with our expectations for $(p \rightarrow \pi^-|\pi^- \leftarrow \pi^+)$ and $(p \rightarrow \pi^-|\pi^+ \leftarrow \pi^-)$. (auth)

16735 PIONIC AND ELECTROMAGNETIC PRODUCTION OF η IN A MODEL OF HIGHER BARYON COUPLINGS. Ahmed, S. A. S.; Mitra, A. N. (Department of Physics and Astrophysics, University of Delhi, Delhi, India). Phys. Rev. D 7: No. 7, 2125-2135 (1 Apr 1973).

An s–channel analysis of η–production processes induced by pions and photons on protons is made in the momentum region 2.9–13.3 GeV/c. The analysis is carried out in a model of higher baryon couplings, which is characterized by a relativistic extension of a broken $SU_6 \otimes O_3$ with partial symmetry scheme for $\bar{B}B_L P$ and $\bar{B}B_L V$ couplings in a unified fashion. In this high–energy extension of the model we incorporate seven baryon trajectories, viz. $N_\alpha(938)$, $N_\beta(1530)$, $N'_\beta(1715)$, $N'_\beta(1675)$, $N_\gamma(1520)$, $N'_\gamma(1675)$, and $N_\delta(1860)$ for which we cary out piecewise summation over the contributions of the particles involved in the corresponding towers, formally up to infinity. The predictions of the theory are compared with experiment with respect to the (i) total and differential cross sections and the recoil neutron polarization for the process $\pi^-p \rightarrow \eta n$ and, (ii) differential cross sections for the process $\eta p \rightarrow \eta p$, at several incident energies. In general the agreement with experiment is rather good up to ≃10 GeV/c. The reasons for the success up to this momentum, as well as the limitations to extension beyond this value, are discussed in the context of contemporary ideas. (auth)

16736 ENERGY DEPENDENCE OF THE DIFFERENCE OF $\pi^{\pm}P$ TOTAL CROSS SECTIONS AND CURVATURE OF THE ρ TRAJECTORY. Berger, Edmond L.; Sivers, Dennis (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 7, 2032-2035 (1 Apr 1973).

We discuss curvature of the ρ Regge trajectory expected at small $|t|$ owing to unitarity effects from the elastic ππ threshold at $t=4m_\pi^2$. This curvature may help to reconcile the discrepancy between experimental determinations of energy dependence for the process $\pi^-p \rightarrow \pi^0n$ and the difference $\Delta^{\pi p}=\sigma_{tot}^{\pi^-p}-\sigma_{tot}^{\pi^+p}$, both mediated by ρ exchange. However, a trajectory function incorporating this curvature by means of a simple threshold expansion of the unitarity expression in unable to accommodate the data and to extrapolate to $\alpha=1$ near the $(\text{mass})^2$ of the ρ. (auth)

16737 TRANSVERSITY–AMPLITUDE ANALYSIS OF THE REACTIONS $K^-p \rightarrow (\omega,\phi)\Lambda$. Field, R. D.; Eisner, R. L.; Chung, S. U.; Aguilar–Benitez‡, M. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 7: No. 7, 2036-2045 (1 Apr 1973).

We present a model–independent amplitude analysis of the reactions $K^-p \rightarrow (\omega\phi)\ \Lambda$ using combined data at 3.9 and 4.6–GeV/c incident momenta. The joint correlations between the vector meson and the Λ hyperon, in addition to the single density–matrix elements and the Λ polarization, are observed and the magnitudes and four relative phases of the six independent transversity amplitudes which describe the reactions are determined. The amplitudes for $K^-p \rightarrow \phi\Lambda$ are compared with results from a similar analysis of $\pi^-p \rightarrow K^{*0}\Lambda$ and excellent agreement with the quark–model prediction of equality of the amplitudes is found. In addition, for the reaction $K^-p \rightarrow \omega\Lambda$ we make some model–dependent assumptions which allow the determination of the structure of the s–channel helicity amplitudes. These amplitudes are compared with duality predictions and implications concerning absorption prescriptions are discussed. (auth)

16738 COMMENT ON THE PARAMETERS OF THE 3–3 RESONANCE. Cheng, T.–Y.; Lichtenberg, D. B. (Department of Physics, Indiana University, Bloomington, Indiana 47401). Phys. Rev. D 7: No. 7, 2249-2251 (1 Apr 1973).

We exhibit a simple 3–parameter formula for the phase shift of the 3–3 pion–nucleon resonance which yields a mass parameter M=1243 MeV, and a width parameter Γ=152 MeV, values considerably higher than previously obtained. However, the position of the pole of the amplitude is $E_{pole}=1211-51i$ MeV, a value close to that found by Ball, Campbell, Lee, and Shaw. Our result lends support to their conclusion that E_{pole} is the relevant quantity, rather than the parameters entering a phenomenological formula for the 3–3 phase shift. (auth)

16739 UNIVERSAL MULTIPLICITY FORMULA. Carruthers, P.; Duong-Van, M. (Cornell Univ., Ithaca, NY). Phys. Lett.; 4B: No. 6, 507-510(11 Jun 1973).

Thermodynamic reasoning is used to derive a universal multiplicity formula for particle production in high energy collisions. Among the results are the equality of πp, pp, and γp multiplicity, the prediction of a slow decrease in deep inelastic multiplicity

when Q^2 increases, and the prediction of an $s^{\frac{1}{2}}$ dependence of hadronic multiplicity in e^+-e^- annihilation. (auth)

16740 SLOPE OF THE πN CHARGE-EXCHANGE AMPLITUDE AT t = 0. Jakob, H. P.; Kroll, P. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B58: No. 1, 269-282(1973).

A dispersion method is investigated which allows the slope of the πN amplitude A'(–) to be determined from the slope of its modulus without knowledge of the complex zeroes. The slope of this amplitude is calculated explicitly and the results are compared with model amplitudes. Our prediction favors models with a very strong t-dependence of the ρ-contribution. (auth)

16741 DUALITY AND REGGE ABSORPTION MODELS. Worden, R. P. (Univ. of Michigan, Ann Arbor). Nucl. Phys.; B58: No. 1, 205-236(1973).

Pion–nucleon charge-exchange FESRs show that the best current Regge absorption models are not dual. Their strong disagreement with the FESRs is surprising, in view of the well-known correspondence between absorptive zeroes and low-energy resonance zeroes. It is shown that the non-duality does not arise from small details of the models, but follows inevitably from certain basic features which they share. To give the absorption the required phase, current models all introduce a strong low-lying j-plane component in the region $0 > j > -1$. This component overwhelms the ρ pole at low energies, producing a non-dual amplitude. Some possible remedies are discussed. (auth)

16742 ELECTROMAGNETIC FORM FACTORS AND VECTOR-MESON COUPLING CONSTANTS. Zovko, N. (Rudjer Boskovic Inst., Zagreb). Acta Phys. Austr.; 36: No. 4, 354-367(1972).

Simple models of nucleon form factors based on vector-meson dominated dispersion relations and asymptotic conditions are analyzed and compared with experimental data. The well known one-parameter dipole fit is replaced by a more transparent one-parameter formula which naturally follows from the $\rho-\omega-\phi$ dominance hypothesis, supplemented by an asymptotic condition. Other more realistic models with additional still unobserved vector mesons are formulated, and model-dependent evaluations of meson–nucleon coupling constants are presented. (auth)

16743 LOW-ENERGY LIMIT OF THE σ MODEL. Guralnik, G. S. (Department of Physics, Brown University, Providence, Rhode Island 02912); Tsao, Hung-sheng; Wong, T. F. Phys. Rev. D 7: No. 8, 2467-2482 (15 Apr 1973).

Recently, Li and Pagels indicated that there might be nonanalytic corrections as bad as $m^2_\pi \ln m^2_\pi$ in the matrix elements. We study the nonanalytic corrections in a renormalized linear σ model in the one-loop approximation. Although we observe these corrections [of the form $\ln m^2_\pi$, $m^2_\pi \ln m^2_\pi$, $(\not{p}-m)\ln m^2_\pi$, $(\not{p}_1-m)\times(\not{p}_2-m)\ln m^2_\pi$] in individual diagrams, they sum up to zero in the physically interesting amplitudes (pion and nucleon propagators, $\pi\pi$ and πN scattering amplitudes). We conclude that the nonanalytic correction is of higher order and thus does not invalidate the low-energy results derived from phenomenological Lagrangian for these amplitudes. (auth)

16744 MESON CHARGE-EXCHANGE REACTIONS IN A REGGE-CUT VAN HOVE MODEL. Holden, J. P.; Robertson, D. C. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). Phys. Rev. D 7: No. 9, 2693-2700 (1 May 1973).

We present an analysis of four meson charge-exchange reactions ($\pi^- p\to\pi^0 n$, $\pi^- p\to\eta^0 n$, $K^- p\to\bar{K}^0 n$, and $K^+ n\to\bar{K}^0 p$) within the context of our Regge-pole-cut model based on the Durand-Van Hove model. Quite good fits to all differential cross sections and polarizations are obtained. Predictions for the KN charge-exchange polarizations are also presented. (auth)

16745 RESIDUE OF THE πN 3-3 RESONANCE POLE. Ball, James S. (University of Utah, Salt Lake City, Utah 84112); Lee, Paul S.; Shaw, Gordon L. Phys. Rev. D 7: No. 9, 2789-2790 (1 May 1973).

The recent, extremely precise measurements of Carter et al. led to widely different values of the mass and width of the πN 3-3 resonance depending on the particular resonance formulas used. We had shown, however, that the position of the S-matrix pole in the complex plane had a unique value $M_{33} = 1211 - 50i$ MeV. We report here that the residue of the pole $R/(M_{33}-W)$ in $T\ [= (S-1)/2i]$ has the unique value $R = 53\, e^{i0.81}$ MeV. We are unable to interpret these four fundamentals parameters M_{33} and R. We thus present it as a basic, important problem to understand these parameters in a model-independent manner. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 16856 and 17114.

16746 (COO-1545-125) GENERATING FUNCTIONS AND KNO SCALING MODELS. Aubrecht, G. J. II; Tanaka, K.; Torgerson, R. (Oregon Univ., Eugene. Inst. of Theoretical Science; Ohio State Univ., Columbus. Dept. of Physics). 1973. Contract AT(11-1)-1545. 15p. Dep. NTIS $3.00.

The generating functions of empirically motivated KNO scaling models are obtained. The generating functions are used to obtain the asymptotic correlation function $f_k \sim \langle n\rangle^k$ ($\langle n\rangle$ is the average charged multiplicity). This is compared with various models of production mechanisms. (auth)

16747 (JINR-D-6840, pp 205-209) STUDY OF THE ΛN INTERACTION BY MEANS OF HYPERNUCLEAR γ-SPECTROSCOPY. Piekarz, H. (Inst. of Nuclear Research, Warsaw). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

From the Λp potential parameters one can estimate the Λp elastic scattering cross sections and compare them with the experimental data obtained at low energies. The estimated values of the singlet and triplet state scattering parameters differed markedly for both Λn and Λp potentials. This indicates a rather strong spin dependence of the Λn interaction. Also the excitation energy of a second mass number 4 hypernucleus was predicted to be higher than 1 MeV for all fitted potentials. (JFP)

16748 (JINR-D-6840, pp 270-287) SPIN–PARITY ANALYSIS OF THREE-PARTICLE BARYON RESONANCES PRODUCED IN QUASI-TWO-BODY PROCESSES. Bednar, M. (Inst. of Physics, Prague). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The angular distributions of three-particle systems in the energy region of three-particle baryon resonances produced in the quasi-two-body processes baryon–baryon or baryon–antibaryon respectively are derived. The angular distributions are obtained without any simplified assumptions about the structure of amplitudes for the production or decay processes of a baryon resonance. It is assumed that the nonresonant background amplitude is nonzero. (JFP)

16749 (JINR-D-6840, pp 298-308) COHERENT AND INCOHERENT HIGH ENERGY PARTICLE INTERACTIONS WITH ATOMIC NUCLEI. Tarasov, A. V.; Tkachev, L. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16750 (JINR-E1-7163) PROBABILITY OF QUASI-TWO-BODY TRANSITIONS AT HIGH ENERGIES. Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 8p. Dep. NTIS (U. S. Sales Only) $3.00.

It is shown that the resonance production cross sections in N–N interactions, normalized to the statistical weights of the final states, dominate in the processes of one and two meson production. (auth)

16751 (JINR-E1-7215) SLOPE PARAMETER AND THE REAL PART OF THE P–N ELASTIC SCATTERING AMPLITUDE IN THE ENERGY RANGE OF 10 TO 70 GeV. Beznogikh, G. G.; Buyak, A.; Zhidkov, N. K.; Zayachki, V. I.; Zolin, L. S.; Kirillova, L. F.; Nikitin, V. A.; Nomokonov, P. V.; Sviridov, V. A.; Truong Bien, Shafranova, M. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

The slope parameter of the p–n elastic scattering differential cross section and α_{pn} (the ratio of the real to the imaginary part of the p–n elastic scattering amplitude) were determined in the framework of the Glauber model using the p–d and p–p elastic scattering data at small angles obtained at the Serpukhov accelerator. It is shown that the properties of the p–n scattering amplitude are similar to those of the p–p scattering amplitude: the slope parameter increases with increasing energy, α_{pn} is negative and decreases in its absolute value when energy increases in accordance with dispersion relations. (auth)

16752 (JINR-P2-7234) NECESSITY OF POLARIZATION EXPERIMENTS ON INTERSECTING P–P AND ANTI P–P BEAMS. Kopeliovich, B. Z.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 16p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

It is shown that when interference between strong ("hadronic") and spin-dependent electromagnetic interactions is taken into account polarization at small t = 3 tc in pp($\bar{p}p$) elastic scattering becomes equal to 4.5% if the hadronic amplitude becomes spin-dependent. Deviation for polarization can take place if hadronic amplitudes b^h e^h, f^h become nonzero. The electromagnetic contribution is given for high energies. Using the results of previous work relative phases for different amplitudes are given. For the elastic cross section the magnetic moment contribution is compatible (and smaller) with nonsingular contribution to σ_{pp} from usual charge-charge interaction. In a more general case the

measurement of polarization gives a triplet contribution to the total cross section. The investigation of different polarization effects at small t in the case of ISR or at accelerators with a stationary target gives a possibility for direct determination of the real and imaginary parts of amplitudes when one measures different components of the polarization correlation tensor C. (auth)

16753 (KFK-EXT-3/72-10) PARTICLE PRODUCTION IN THE FRAMEWORK OF THE NUCLEAR CASCADE MODEL. Schneider, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jan 1973. 93p. (In German). Dep. NTIS (U. S. Sales Only) $6.75.

Inclusive nucleon and pion spectra of the reactions pp, pBe, and pPb are calculated on the basis of nuclear cascade model, using the information on the individual $NN \rightarrow NN + (n-2)\pi$, $\pi N \rightarrow N + (n-1)\pi$, $(n = 2 \ldots 5)$ reactions. The partial cross sections for these processes are taken from experiment or derived from a statistical isospin model. Realistic angular and momentum distributions are obtained by taking into account the relativistic phase space and approximating the remaining dynamical effects by the model of Sosnowski and Wojcik. The numerical evaluation is done in the framework of a Monte Carlo calculation, where energy- and momentum conservation is taken into account for each event. The calculations are performed at a laboratory momentum of 10 GeV/c and compared with an experiment done by Dekkers et al and with the thermodynamical model of Hagedorn. (auth)

16754 (NP-19801) INVARIANT DESCRIPTION OF PERIPHERAL THREE-PARTICLE FINAL STATES. Byckling, E.; Raitio, R.; Tuominiemi, J. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1972. 22p. Dep. NTIS (U. S. Sales Only) $3.25.

A way to describe three body final state reactions by one essential invariant variable is proposed. As an example the application of the method to the reaction $pp \rightarrow p\pi^+n$ is discussed. (auth)

16755 (NP-19804) MONTE CARLO SIMULATION OF HIGH-ENERGY REACTIONS ACCORDING TO THE FRAGMENTATION MODEL. Pirilae, P.; Ruuskanen, P. V. (Jyvaskyla Univ. (Finland). Dept. of Physics). Feb 1973. 21p. Dep. NTIS (U. S. Sales Only) $3.25.

The program SIMULATOR FOR FRAGMENTATION written in FORTRAN IV for the CDC 6600 is used to calculate the number and momenta of final-state particles according to the fragmentation model. Only proton–proton, pion–proton, and pion–pion collisions are allowed, and only pions may be produced. (JFP)

16756 (RL-73-45) HIGH TRANSVERSE MOMENTUM HADRON JET PRODUCTION IN A GLUON-EXCHANGE MODEL. Montvay, I. (Rutherford High Energy Lab., Chilton (England)). Jun 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

Properties of the high transverse momentum single particle distribution in proton-proton collisions are investigated in a simple phenomenological model based on strong gluon exchange between partons. It is shown that a large p_T behavior p_T^{-n} with n between 4 and 12 can be accommodated in the model. The importance of less model-dependent features like the cross section for the jet production itself is emphasized. (auth)

16757 (TAUP-251-71) GRAPHIC DUALITY AND THE ALGEBRA OF VERTEX STRENGTHS. Kantorovich, A.; Stumer, I.; Ne'eman, Y. (Tel Aviv Univ. (Israel). Dept. of Physics). 1971. 25p. INIS.

It is proven that the Regge exchange part of Im A(s,t) in graphical duality is given exactly by symmetric $[U(3) \times U(3)]_B$ "CHN" couplings. Adopting the physical picture implied by graphical duality thus requires the adjunction of a nineteenth operator in CHN, to represent the diffractive contribution. A Casimir operator is introduced which reproduces the Levin–Frankfurt ratio of $\sigma_{TOT}(NN)$: $\sigma_{TOT}(\pi N) \rightarrow 3:2$. The experimental situation is examined in that light. (auth)

16758 PION CONDENSATION IN SUPERDENSE NUCLEAR MATTER. Sawyer, R. F.; Scalapino, D. J. (Department of Physics, University of California, Santa Barbara, California 93106). Phys. Rev. D 7: No. 4, 953-964 (15 Feb 1973).

Previous work, based on the interaction of only one mode of the pion field with nucleons, indicated the possibility that the ground state of nuclear matter at densities above some onset density would consist of a coherent mixture of protons, neutrons, and pions, the latter condensed in a plane-wave state of momentum $\simeq$170 MeV/c. The model is now made more realistic by inclusion of ordinary nuclear forces, emission and absorption of noncondensed pion modes, S-wave pion–nucleon interactions, and pion–pion interactions. A pion condensation is again predicted, with onset between $\rho=0.5$ baryons/F^3 and $\rho=1$ baryon/F^3. Some possible consequences for neutron stars are discussed. (auth)

16759 EVIDENCE FOR TWO COMPONENTS IN HIGH ENERGY pp COLLISIONS. Lach, J.; Malamud, E. (National Accelerator Lab., Batavia, IL). Phys. Lett.; 44B: No. 5, 474-476 (28 May 1973).

It is noted that high energy charged particle multiplicity data in pp collisions is a poor fit to a single Poisson distributions for $p_L \geq 200$ GeV/c. A good fit is obtained to a double Poisson distribution with constant cross section and constant multiplicity for the lower multiplicity component; the interpretation of this result is discussed. (auth)

16760 RESCATTERING EFFECTS IN BACKWARD PROTON–DEUTERON SCATTERING AT INTERMEDIATE ENERGIES. Bhasin, V. S. (T. W. Bonner Nuclear Laboratories, Rice University, Houston, Texas 77001). Phys. Rev. D 7: No. 7, 2066-2073 (1 Apr 1973).

We study backward proton–deuteron scattering at intermediate energies (1.0–1.5 GeV) by considering a rearrangement process where the incident projectile picks up a neutron of the target leaving the target proton behind. By collecting terms up to second order in the multiple–scattering series and by employing the approximations suited to a high–energy large–angle scattering behavior, we obtain the expression for the scattering amplitude similar (but not identical) to the one used by the Glauber model for small–angle scattering at these energies. We find that the double–scattering terms, in which the incident proton scatters with the neutron in the forward direction and then sends the target proton back, contribute most significantly. The lowest–order "pickup" and the single–scattering terms become important if one includes the tensor component in the deuteron wave function. The calculated differential cross section (particularly at intermediate angles) is found to be in reasonable agreement with experimental data. (auth)

16761 RECENT HIGH–ENERGY MULTIPLICITY DISTRIBUTIONS IN THE CONTEXT OF THE FEYNMAN FLUID ANALOGY. Bander, Myron (National Accelerator Laboratory, P. O. Box 500, Batavia, Illinois 60510). Phys. Rev. D 7: No. 7, 2256-2258 (1 Apr 1973).

Recent accelerator data on multiplicity distributions are reexamined within the context of the Feynman fluid analogy. An interpretation of the data put forward is that the diffractive component decreases logarithmically with energy. (auth)

16762 POLARIZATION IN n–p SCATTERING WITH SEPARABLE POTENTIALS. Lambacher, H.; Urban, P. (Univ., Graz). Acta Phys. Austr.; 36: No. 1, 39-43(1972).

It will be shown that the separable Yamaguchi potential is not able to produce any polarization effects in spite of the inclusion of a tensor interaction. This is a consequence of the fact that the Yamaguchi potential is of rank one. (auth)

16763 INELASTIC COLLISIONS BETWEEN DEUTERONS WITH 2.43 GeV/c AND ATOMIC NUCLEI OF PHOTOGRAPHIC EMULSION. Siles, E.; Tucke, J. (Univ., Kosice, Czech.). Fyz. Cas.; 22: No. 3, 163-169(1972).

Inelastic collisions are discussed between deuterons and atomic nuclei during which a high speed deuteron is emitted from the nucleus as a secondary particle. The particles are identified in relation to the ionization dependence on $p\beta$. A model of the cascade of interactions of a primary particle and relatively independent static nucleons is used in interpreting the observed collisions of deuterons and atomic nuclei. The absorption cross section makes it possible to evaluate the mean free path of the primary particle inside the nucleus and the probability of single and souble interactions in the nucleus. The observed number of secondary deuterons was used in estimating the probability that during a single collision in the cascade inside the nucleus a deuteron had not disintegrated into its components. (auth)

16764 MULTIPLICITY DISTRIBUTION IN HIGH–ENERGY PP COLLISIONS. Hoang, T. F (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 9, 2799-2802 (1 May 1973).

An analysis is made of the fluctuation observed in the multiplicity distribution at 205 GeV/c. A compound Poisson distribution is proposed to describe the distribution of multiparticle production. Applications are given to currently available pp data. (auth)

16765 EMPIRICAL FORMULA FOR PION PRODUCTION IN PROTON–PROTON COLLISIONS UP TO 1500 GEV. Wang, C. L. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. D 7: No. 9, 2609-2613 (1 May 1973).

A semiempirical formula which well represents the double–differential cross section for pion production in high–energy pp collisions is presented. The formula agrees with all data between 20 and 1500 GeV to within a factor of $\sim$2 and is consistent with scaling and limiting fragmentation. Also presented is a set of momentum spectra at some interesting energies. (auth)

16766 EXTRAPOLATION OF THE PP FORWARD SCATTERING AMPLITUDE. Kanazawa, A. (Department of Physics,

Hokkaido University, Sapporo, Japan). Phys. Rev. D 7: No. 9, 2626-2629 (1 May 1973).

The pp forward spin–nonflip amplitude is analytically continued by Ciulli–Cutkosky–Deo method. The resultant amplitude has qualitatively the same characteristic features as that observed by Sugawara and the present author in their iterative method. In particular, it is quite conclusive that the spin flip cannot be neglected in the high–energy region up to about 30 GeV/c. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 17316.

16767 (CNRS-CPT-73-P-517) COMPOSITION OF COHERENT SPIN STATES. Bellissard, J.; Holtz, R. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jan 1973. 6p. Dep. NTIS (U. S. Sales Only) $3.00.

Clebsch–Gordan coefficients for the SU(2) group are computed in the coherent spin state basis introduced by J. M. Radcliffe. (France)

16768 (NP-19800) IS CP VIOLATED IN THE $(3,\bar{3}) + (\bar{3},3)$ MODEL OF THE CHIRAL SYMMETRY. Saliu, L.; Tataru, L. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1972. 11p. Dep. NTIS (U. S. Sales Only) $3.00.

The existence of a CP violation term belonging to the $(3,\bar{3}) + (\bar{3},3)$ chiral representations is discussed. A recent comment of Beg about the order-of-magnitude difficulties which should appear in this model is re-examined. (auth)

16769 BROKEN COLLINEAR SU(6) SYMMETRIES AND THE SUPPRESSION OF $|\Delta S| = 1$ AMPLITUDES. Oehme, R. (Univ. of Chicago). Phys. Lett.; 44B: No. 5, 468-470(28 May 1973).

Within the framework of the general mapping between collinear SU(6) algebras in the current- and the constituent-quark picture, a unitary transformation involving the quark mass matrix $M = \lambda_0 + c\lambda_8$ is introduced. It results in a weight factor between $\Delta S = \pm 1$ and $\Delta S = 0$ amplitudes. With a specific boundary condition, one obtains $\text{tg}\ \theta = \cos\ (\pi c/2\sqrt{2})$ θ = Cabibbo angle. (auth)

16770 SPECIAL TYPE OF ISOSCALAR FACTORS FOR THE SEMICANONICAL BASIS OF U_n. Alishauskas, S. I.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; XIII: No. 1, 5-10(1973). (In Russian).

The special isoscalar factors of the Clebsch–Gordan coefficients of the unitary group in the case of the Kronecker product $[a0\ldots0-b] \times [E0\ldots0]$ reduced to $[E'0\ldots0]$, are considered. It is shown that such isoscalar factors for the semicanonical basis (U_n is reduced with respect to $U_{n_1} + U_{n_2}$, $n_1 + n_2 = n, n_1 > 1, n_2 > 1$) are proportional to the Clebsch–Gordan coefficients of SU_2. Some new symmetry properties and simplification rules of the isoscalar factors of U_n are described. (auth)

16771 EINSTEIN GROUP AND THE SYMMETRY GROUPS OF GRAVITATION THEORY. Treder, H. J. (Forschungsbereich Kosmische Physik, Potsdam, Ger.). Ann. Phys. (Leipzig); 28: No. 4, 333-340(1973). (In German).

The transformations $\mathfrak{X}^\alpha = \mathfrak{X}^\alpha(x^\beta, g_{\mu\nu})$ in the function space of the $g_{\mu\nu}(x^\lambda)$ correspond to the coordinate transformations $x'^\alpha = x'^\alpha(x^\beta)$ with some noncovariant conditions on the $g_{\mu\nu}(x^\lambda)$. Therefore, the transformations in the function space correspond to subgroups of the Einstein group. The conditions for the $g_{\mu\nu}$ may be given in the space-time V_4 or on submanifolds (points, curves, surfaces and hypersurfaces) of the V_4. A special case of the last problem is given by the Cauchy conditions or by the Dirac constraints for a special choice of the coordinates on a Cauchy hypersurface $x^0 = 0$. Then, the transformations $\mathfrak{X}^\alpha = \mathfrak{X}^\alpha(x^1, g_{rs}, p^{mn})$ in the phase space are Einstein transformations preserving the synchronicity for $x^0 \to 0$. (auth)

16772 RELATIVISTIC ALGEBRAIC ANALOGS OF THE CHARGED HARMONIC OSCILLATOR. Hieggelke, C. J.; Joseph, D. W. (University of Nebraska, Lincoln, Nebraska 68508). Phys. Rev. D 7: No. 8, 2390-2404 (15 Apr 1973).

A new relativistic algebraic analog of the harmonic oscillator is constructed, based on the algebra of the pseudo–orthogonal group SO(3,2) and a certain family of Hermitian representations which have the level and multiplet structure of the harmonic oscillator. This SO(3,2) oscillator approaches the nonrelativistic oscillator in the limit in which the parameter Ω which labels the representations tends to infinity. The relativistic character of the SO(3,2) oscillator depends on the fact that the generators include a Lorentz subalgebra together with a set which transforms as a four–vector under that subalgebra and permits the construction of a conserved covariant electromagentic current. It is found that the "minimal" such current coincides with the electromagnetic current of the harmonic oscillator in the nonrelativistic limit. The SU(3,1) oscillator model previously described by Cocho et al. is also investigated with regard to the electromagnetic current, its conservation and its nonrelatistic limit. The two models are qualitatively very similar, except that the SO(3,2) oscillator with 10 generators is somewhat simpler than the SU(3,1) oscillator with 15. (auth)

16773 IDENTITY SATISFIED BY THE D-TYPE COEFFICIENTS OF SU(N). Rashid, M. A. (Institute of Mathematics, University of Islamabad, Pakistan); Saifuddin. J. Math. Phys. (N.Y.) 14: No. 5, 630-631 (May 1973).

Using a very simple approach, we obtain one identity for each SU(n), satisfied by its d-type coefficients. (auth)

16774 ALLOWED DOMAINS FOR CHIRAL–SYMMETRY AND ISOSPIN–BREAKING PARAMETERS. Hu, B. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. D 7: No. 8, 2483-2489 (15 Apr 1973).

In addition to the chiral–symmetry–breaking terms $\epsilon_0\delta_0 + \epsilon_8\delta_8$, $\epsilon_8\theta_8$, an isospin–breaking term $\epsilon_3\theta_3$ is included in the study of the $(3,\bar{3})+(\bar{3},3)$ model. By assuming that the intermediate symmetry is either $SU_2 \otimes SU_2$ or SU_3, allowed domains for the chiral–symmetry and isospin–breaking parameters are derived. A θ–model Lagrangian is then constructed. The positivity condition for the masses reproduces the general features of the domain structure. (auth)

16775 CONFORMAL GROUP IN A POINCARÉ BASIS. III. DEGENERATE SERIES. Macfadyen, N. W. (Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, England). J. Math. Phys. (N.Y.) 14: No. 5, 638-646 (May 1973).

We construct systematically all the unitary irreducible representations of the group SU(2,2) which are realized on the two manifolds Z and $\tilde{Z}$ introduced in Paper I of this series; these include all the degenerate representations at present known apart from the exceptional or ladder series. This particular realization of the global theory displays the Poincaré subgroup in a simple form, and we examine the reduction products under this group. We find that the degenerate first series contain only spacelike momenta and a single spin fixed by the invariants of SU(2, 2); the degenerate second series on the other hand contain only spinless representations of P, while the nature of the momenta which appear depends on the particular series concerned. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 16518, 16599, 16600, 16621, 16628, 16654, 16656, 16662, 17012, 17094, and 17290.

16776 (RL-73-17) SU(3) × SU(3) MODEL FOR HADRONS AND LEPTONS. Ross, G. G. (Rutherford High Energy Lab., Chilton (England)). Apr 1973. 9p. Dep. NTIS (U. S. Sales Only) $3.00.

A unified gauge theory for the weak and electromagnetic interactions is constructed which suppresses the strangeness changing neutral currents and yet has approximate SU(3) × SU(3) hadronic symmetry and a conventional quark structure. (auth)

16777 "CLASHING SYMMETRIES" IN UNIFIED DESCRIPTIONS OF ELECTROMAGNETIC AND WEAK INTERACTIONS, AND THE CASE OF THE HAN–NAMBU MODEL. Lipkin, Harry J. (National Accelerator Laboratory, Batavia, Illinois 60510). Phys. Rev. D 7: No. 6, 1850-1853 (15 Mar 1973).

Difficulties encountered in constructing unified descriptions of electromagnetic and weak interactions are simply characterized in terms of the "clash" between the new symmetries needed and the old symmetries already present in hadron dynamics. Unobserved new particles and new decay modes are predicted and must be explained away. The Han–Nambu model is suggested as one which already contains some of the features which are added ad hoc in other models. (auth)

16778 CAN ALL HADRONIC SYMMETRY BREAKING BE DUE TO WEAK INTERACTIONS?. Weinstein, Marvin (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 6, 1854-1861 (15 Mar 1973).

We define, in very general terms, a class of theories in which it is possible for all symmetries such as SU(3) and SU(3) ⊗SU(3) to be exact if one turns off all couplings of leptons and hadrons; but nevertheless, one can have ten– to twenty–percent violations of these symmetries coming about as a direct consequence of extremely weak lepton–hadron couplings. A framework is proposed for discussing these schemes which is independent of specific Lagrangian models and so leaves open the question of whether or not the Goldstone bosons

appearing in these schemes are elementary or composite. For pedagogical purposes tha last section of this paper is devoted to a brief discussion of a simple Lagrangian model having the various properties set out in our general scheme. (auth)

16779 CPT VIOLATION AND THE $K_L \to \mu^+\mu^-$ PUZZLE. Achiman, Yoav (Institut für Hochenergiephysik, Universität Heidelberg, Heidelberg, Germany). Phys. Rev. D 7: No. 5, 1515-1519 (1 Mar 1973).

The effects of possible CPT violation on the $K_L \to 2\mu$ amplitude are found to be concentrated at the right place to suppress the experimentally violated "conventional" unitarity bound, irrespective of $K_s \to 2\mu$. CPT nonconservation may, therefore, resolve the $K_L \to 2\mu$ puzzle, even if CP violation or the recently proposed new interactions will fail to do this. The possible breaking of CPT invariance is studied systematically and bounds are given on the violating part of the related amplitudes. Only nonconservation of CPT in the absorptive part of the $K_L \to 2\mu$ amplitude (e.g., in $K_L \to 2\gamma$) may be accessible to experiment in the near future. Superweak theory is inconsistent with experiment, under the "conventional" assumptions, even in its CPT-violating version. (auth)

16780 GENERAL THEORY OF BROKEN LOCAL SYMMETRIES. Weinberg, Steven (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 4, 1068-1082 (15 Feb 1973).

A general formalism for theories with spontaneously broken local symmetries is developed in the unitarity gauge. The canonical quantization procedure is carried out, leading to a set of Lorentz-covariant Feynman rules. Various special topics are discussed. (auth)

16781 C VIOLATION IN ELECTROMAGNETIC INTERACTIONS. Mani, H. S.; Ramachandran, R. (Department of Physics, Indian Institute of Technology Kanpur, Kanpur, India). Phys. Rev. D 7: No. 5, 1491-1495 (1 Mar 1973).

We have considered the reactions $e^+e^- \to \rho^0 + \gamma$ and $e^+e^- \to \mu^+ + \mu^- + \gamma$ with a view to detecting $\rho\gamma\gamma$ and $\gamma\gamma\gamma$ vertices. It is found that, depending on the nature of the form factors involved in these vertices, there could be substantial deviation from the normal cross section at energies available in the present-day colliding-beam machines. (auth)

16782 RADIATIVE CORRECTIONS AS THE ORIGIN OF SPONTANEOUS SYMMETRY BREAKING. Coleman, Sidney; Weinberg, Erick (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 7: No. 6, 1888-1910 (15 Mar 1973).

We investigate the possibility that radiative corrections may produce spontaneous symmetry breakdown in theories for which the semiclassical (tree) approximation does not indicate such breakdown. The simplest model in which this phenomenon occurs is the electrodynamics of massless scalar mesons. We find (for small coupling constants) that this theory more closely resembles the theory with an imaginary mass (the Abelian Higgs model) than one with a positive mass; spontaneous symmetry breaking occurs, and the theory becomes a theory of a massive vector meson and a massive scalar mason. The scalar-to-vector mass ratio is computable as a power series in e, the electromagnetic coupling constant. We find, to lowest order, $m^2(S)/m^2(V) = (3/2\pi)e^2/4\pi$. We extend our analysis to non-Abelian gauge theories, and find qualitatively similar results. Our methods are also applicable to theories in which the tree approximation indicates the occurrence of spontaneous symmetry breakdown, but does not give complete information about its character. (This typically occurs when the scalar-meson part of the Lagrangian admits a greater symmetry group than the total Lagrangian.) We indicate how to use our methods in these cases. (auth)

16783 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT AND THE $\pi^0 \to 2\gamma$ DECAY RATE. Drell, S. D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). Phys. Rev. D 7: No. 7, 2190-2205 (1 Apr 1973).

The difference between applying partial conservation of axial-vector current (PCAC) to the amplitude for $\pi^0 \to 2\gamma$ decay, which involves products of local currents, and to amplitudes involving composite hadrons, where it has enjoyed its notable successes-viz., the Goldberger-Treiman relation, the Adler-Weisberger sum rule, and the Adler consistency condition—is analyzed. Using the Bell-Jackiw-Adler theory of the PCAC anomaly, we show that this difference provides a mechanism for removing the factor-of-10 discrepancy that is usually claimed to exist between the observed decay rate and the one calculated on the basis of the original Gell-Mann—Zweig quark model with one triplet of fractionally charged quarks. An essential dynamical assumption is that pion-pole dominance is valid only for those matrix elements of the divergence of the axial-vector current taken with composite hadronic states; this is akin to features in the "weak PCAC" of Brandt and Preparata. A specific model of the hadron as a Bethe-Salpeter bound state of two pointlike constituents is used to illustrate the underlying dynamical mechanism. It follows from this that there should be a sizable enhancement above the PCAC prediction by Adler for forward-angle high-energy very inelastic neutrino-hadron cross sections. Verification of this prediction will be a crucial test of our theory. (auth)

16784 SU(3) PREDICTIONS FOR SINGLE-PARTICLE DISTRIBUTIONS IN DEEP ANNIHILATION AND DEEP INELASTIC ELECTROPRODUCTION. Kingsley, R. L. (Cambridge Univ., Eng.). Nucl. Phys.; B58: No. 1, 195-204(1973).

Predictions designed to test natural ideas based on SU(3) symmetry are derived for the processes $e^+ + e^- \to h + X$ and $e + p \to e + h + X$ in the quark parton model and bounds are obtained for these processes. (auth)

16785 NONRENORMALIZATION THEOREM IN THE CHIRAL SYMMETRY LIMIT. Langacker, Paul; Pagels, Heinz (The Rockefeller University, New York, New York 10021). Phys. Rev. Lett. 30: No. 13, 630-633 (26 Mar 1973).

We show that the form factors of the strangeness-changing current are renormalized in first order, rather than second order, in the symmetry-breaking parameters if the chiral symmetry is realized by Nambu-Goldstone bosons. The first-order renormalization is explicitly calculated for the meson and baryon form factors. (auth)

16786 SU(2) ×U(1) GAUGE THEORIES WITH HAN-NAMBU QUARKS. Rawls, John M.; Yu, Loh-ping (Department of Physics, University of California, San Diego, La Jolla, California 92037). Phys. Rev. D 7: No. 8, 2463-2467 (15 Apr 1973).

Several SU(2) ×U(1) gauge theories of weak and electromagnetic interactions based on Han-Nambu quarks are presented which satisfy all known selection rules of semileptonic and nonleptonic weak interactions, excluding the $\Delta I = 1/2$ rule. (auth)

16787 CANONICAL TRACE ANOMALIES. Chanowitz, Michael S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305); Ellis, John. Phys. Rev. D 7: No. 8, 2490-2506 (15 Apr 1973).

We discuss the anomalies present in broken-scale-invariance trace identities which result from assuming that products of hadronic currents have a canonical singularity structure at short distances. The analysis is performed qualitatively in configuration space and quantitatively in momentum space. Canonical anomalies are found in trace identities involving two electromagnetic currents, or two axial-vector currents or their divergences. There are related canonical anomalies in trace identities involving three or four currents. They can be represented by the anomalous trace equation $\theta_\lambda^{\lambda\,\text{anomalous}}(x) = \theta_\lambda^\lambda(x) + (R/32\pi^2)\tilde{F}^i_{\mu\nu}F^{i\mu\nu}_i$, where $\tilde{F}^i_{\mu\nu} = \partial_\mu F^i_\nu - \partial_\nu F^i_\mu + h_{ijk}F^j_\mu F^k_\nu$, with the F^i_μ external fields coupled to the SU(3) × SU(3) currents, and h_{ijk} the structure constants of SU(3) × SU(3). The electromagnetic current trace anomaly is related to the high-energy cross section for $e^-e^+ \to \gamma \to$ hadrons, and via P0T (partially zero trace) to the coupling of a scalar meson to photons. These are connected by

$$(12\pi^2 F_\sigma)^2 \varepsilon_{\sigma\gamma\gamma} = R = \lim_{p^2 \to \infty} \frac{\sigma(e^-e^+ \to \gamma \to \text{hadrons})}{\sigma(e^-e^+ \to \gamma \to \mu^-\mu^+)},$$

where F_σ is defined by $\langle 0|\theta^\mu_\mu|\sigma\rangle = m_\sigma^2 F_\sigma$. The axial-vector current anomalies are related to the high-energy cross sections for $e^-\bar{\nu}_e(\mu^-\bar{\nu}_\mu) \to$ hadrons; they do not affect previous estimates of the $\sigma\pi\pi$ coupling made using broken scale invariance and P0T.

16788 CURRENT-MIXING GAUGE THEORIES OF WEAK AND ELECTROMAGNETIC INTERACTIONS OF HADRONS. Yu, Loh-ping (Department of Physics, University of California, San Diego La Jolla, California 92037). Phys. Rev. D 7: No. 8, 2521-2524 (15 Apr 1973).

Assuming mesons and baryons are composed only of multitriplets of fundamental fermions, we construct renormalizable SU(2) ×U(1)$_Y$ gauge theories of weak and electromagnetic interactions of hadrons. (auth)

16789 DEEP-INELASTIC SCATTERING, THE SUBTRACTION OF DIVERGENT SUM RULES AND CHIRAL-SYMMETRY BREAKING IN THE GLUON MODEL. Jaffe, R. L. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Smith, C. H. Llewellyn. Phys. Rev. D 7: No. 8, 2506-2516 (15 Apr 1973).

The formal light-cone properties of commutators involving current divergences are studied in the gluon model. Relations are derived which make it possible (in principle) to distinguish the vector- from the (pseudo) scalar-gluon model. In the vector-gluon model these relations provide an experimental determination of the bare quark masses. The additional assumption that the residues of any $\alpha = 0$ fixed poles in current scattering amplitudes are polynomials in q^2 makes it possible to relate the σ term in pion-nucleon scattering to convergent integrals over neutrino-scattering structure functions; the polynomial assumption dictates a prescription for subtracting a (linearly) divergent sum rule derived previously. The same technique generates subtracted sum rules for the (neutrino- and spin-dependent) structure functions W^-_3 and G_2. With the parton-model assumption that the leading scaling behavior of current-divergence and divergence-divergence scattering is given by

free-field theory, it is possible to relate fixed-pole residues in ep, en, νp, and νn scattering, deep-inelastic data, the σ term, baryon mass differences, and the bare quark masses; approximate values for the bare quark masses and the parameter μ_0 can be obtained. (auth)

16790 VECTOR-MESON MIXING AND BROKEN NONET SYMMETRY. Kenny, B. G. (The Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 7: No. 9, 2776-2782 (1 May 1973).

Vector-meson mixing is investigated using a simple ansatz for the vector-meson nonet propagator. The first and the modified second spectral-function sum rules of Weinberg are tested using this ansatz. As a consequence it is found that the first sum rules possess a higher symmetry than is usually assumed. The modifications to the second sum rules are found to be incorrect in certain cases. In addition the ω–φ mixing angle is estimated and found to be close to the ideal value. The quantity f_κ/f_π is calculated and used to test the validity of a conjectured modified second sum rule. Finally two independent methods are used to estimate $\Delta(0) = 1/2f_\kappa^2 m_\kappa^2$. Agreement is found between the methods, but the result is found to be larger by a factor of 2 than the usually accepted "standard value." (auth)

Applications (Strong)

Refer also to abstract 16522.

16791 MASS OF THE NINTH PSEUDOSCALAR MESON IN THE FRAME OF BROKEN CHIRAL SU(3) × SU(3). Rodenberg, R. (Technische Hochschule, Aachen). Ann. Phys. (Leipzig); 28: No. 4, 306-314(1973).

Using Gell-Mann's ansatz for the SU(3) ⊗ SU(3) symmetry breaking part $H_{SB} = -u^0 - cu^8$ in the strong Hamiltonian density, where the operators u^j (j = 0, 1, ... 8) are the scalar part of a basis for the (3,3*) ⊗ (3*,3) representation of chiral SU(3) ⊗ SU(3) and where the constant c is a measure for SU(3) breaking within the SU(3) ⊗ SU(3) breaking, a sum rule for the spin zero spectral functions of the pseudoscalar axial vector current octet is derived. Saturating the sum rule with the lowest lying states, the mass of the ninth pseudoscalar meson can be estimated as $m_{\eta_1} = 950$ MeV. (auth)

16792 ON MATRIX SUPERPROPAGATORS. II. Ashmore, J.; Delbourgo, R. (Physics Department, Imperial College, London SW7 2BZ). J. Math. Phys. (N.Y.) 14: No. 5, 569-571 (May 1973).

The techniques developed in a previous paper (I) to compute the T product $<\phi^{\wedge}_{\alpha\beta}(x), \phi^{\wedge}_{\gamma\delta}(0)>$ for arbitrary N are extended to cover the case when φ (x) is a Hermitian matrix-valued field in ν dimensions. We obtain a closed expression which is used to determine superpropagators like $<[\exp k\phi(x)]_{\alpha\beta} = [\exp k\phi(0)]_{\gamma\delta}>$, which occur in strong interaction physics when φ is an SU(3) field, say. (auth)

16793 EXOTIC SU (3) REPRESENTATIONS IN INCLUSIVE REACTIONS. Mathis, H. B.; Capps, Richard H. (Physics Department, Purdue University, Lafayette, Indiana 47907). Phys. Rev. D 7: No. 9, 2734-2738 (1 May 1973).

The general inclusive reaction a+b–c+X is considered in the b fragmentation region. Several well-known hypotheses concerning early scaling in cases of (bc̄) or (abc̄) states of exotic Y (hypercharge) and I_z are extended to states of nonexotic Y and I_z and exotic SU (3) representation. Several testable predictions are made. These may be useful in studying both the SU(3) symmetry of various Regge couplings and the effects of SU(3) mass differences. (auth)

Scattering Theory

Refer also to abstracts 16685, 16687, 16713, and 17296.

16794 (JINR-D-6840, pp 237-252) QUASICLASSICAL APPROACH AND ASYMPTOTIC LIMIT ON QUASIPOTENTIAL PARAMETERS. Goloskokov, S. V.; Matveev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973. (In Russian).

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

16795 (NP-19797) INTEGRAL EQUATIONS FOR N-PARTICLE SCATTERING. Bencze, G. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Mar 1973. 28p. Dep. NTIS (U. S. Sales Only) $3.50.

Integral equations are derived for the N-particle transition operators. The equations couple together only transition operators between two-body channels. The kernel of the equations becomes connected after a single iteration. Transition operators involving channels with three or more particles can be obtained by quadratures from the solution of the equations. It is also shown that the N-particle equations can be reduced to multichannel two-body equations by the use of the quasiparticle method. (auth)

16796 SCATTERING ANALYSIS FOR THE CLASSICAL $\lambda\phi^4$ THEORY. Castell, L. (Max-Planck-Institut zur Erforschung der Lebensbedingungen der Wissenschaftlich-Technischen Welt, Riemerschmidstr. 7, D 813 Starnberg, Germany); Renz, W.-P. Phys. Rev. D 7: No. 4, 1264-1266 (15 Feb 1973).

We consider the classical SO(4) ×SO(2) –invariant solutions of the field equation $\Box\phi - \lambda\phi^*\phi\phi = 0$. For these solutions we calculate asymptotic in- and out-waves, and show that the corresponding S operator is nonlinear on certain states, which however do not obey the spectrum condition. An S matrix for the physical s waves is constructed, assuming unitarity. (auth)

16797 UNITARY VARIATIONAL APPROXIMATIONS. Carew, John (12 Shadow Wood Way, Ballston Lake, New York 12019); Rosenberg, Leonard. Phys. Rev. D 7: No. 4, 1113-1119 (15 Feb 1973).

The problem of generating nonrelativistic three-body scattering amplitudes which satisfy unitarity exactly, at all energies, is studied in the context of an effective-potential theory. It is shown how the nonlinear unitarity relations can be replaced by linear integral equations, simpler in structure than the original Faddeev equations, such that for any set of input amplitudes satisfying standing-wave boundary conditions the output will be unitary. Variational principles for these input amplitudes are derived from the Faddeev equations which define them, so that approximations can be systematically improved. Attention is drawn to a particular class of approximations for which the integral equations to be solved are all of the two-body type. These approximations have the additional virtue that the trial functions which enter into the Schwinger-type variational expression are square-integrable. This property allows for a choice of trial functions based on an "effective-range" type of argument. The Schwinger principle can then be thought of as providing an analytic continuation of the effective potential from an energy domain below the breakup threshold to a limited range above it. (auth)

16798 THREE-PARTICLE SCATTERING WITH THREE-PARTICLE INTERACTIONS. Kowalski, K. L. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. D 7: No. 6, 1806-1813 (15 Mar 1973).

The scattering formalism of Alt, Grassberger and Sandhas, is extended to include a possible three-particle interaction. This is then employed to find a set of scattering integral equations in which no unphysical auxiliary amplitudes related to the three-body force appear as well as to develop a practical method for treating perturbatively the effect of a weak three-body force. The general K-matrix formalism and connected-kernel Heitler equations are also developed. This yields some indication of the structure that might be expected in a relativistic connected-kernel K-matrix formalism. (auth)

16799 BETHE-SALPETER EQUATIONS WITH S=0 SOLUTION AS INPUT. Connell, John H. (Springfield Technical Community College, Armory Square, Springfield, Massachusetts 01105). Phys. Rev. D 7: No. 4, 1221-1224 (15 Feb 1973).

Bethe-Salpeter equations with energy-independent kernels are reexpressed in a form in which the kernel is eliminated and the input is the s=0 scattering solution. In a model of particle-antiparticle scattering in which each particle has mass M and spin (1/2), the greater convergence of this form is exploited in the kinematic region $s \lesssim M^2$ to give analytic scattering solutions when certain approximations are made. A sufficiently strong s=0 input amplitude leads to bound states of mass $\lesssim M$ with explicit vertex functions. The decay amplitude of one bound state into two others is calculated explicitly and found to be of a strength characteristic of the strong interactions. (auth)

16800 ROLE OF THE FUNDAMENTAL TACHYON FIELD IN THE ELASTIC SCATTERING AMPLITUDE. van der Spuy, E. (Atomic Energy Board, Pelindaba, Republic of South Africa). Phys. Rev. D 7: No. 4, 1106-1112 (15 Feb 1973).

In previous papers a fundamental field $\phi_\alpha(x)$ was determined giving a nonperturbative solution of a nonlinear field equation of motion. In one work it was shown how the observable scattering processes corresponding to the fundamental field could be determined in general by applying unitarity to the function $\Delta^+_{\alpha\beta}(x-y) = <0|\phi_\alpha(x)\ \phi_\beta{}^+(y)|0>$. In particular the contribution of the fundamental field components with positive mass-squared values to the direct channel of the elastic scattering amplitude was determined. In the present paper it is shown how the contribution of the fundamental tachyon field component (with negative mass-squared values) to the momentum-transfer channel of the elastic scattering amplitude may be determined. (auth)

16801 SCATTERING OF ELECTRONS IN AN ELECTROMAGNETIC AND HOMOGENEOUS MAGNETIC FIELD. Abakarov, D. I.; Oleinik, V. P. (Inst. of Semiconductors, Kiev). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1549-1554(May 1973). (In Russian).

An exact formula for the probability for quantum transitions of an electron in a homogeneous magnetic field induced by an external electromagnetic field of arbitrary intensity is derived and investigated. The case of a monochromatic electromagnetic wave

as well as that of a finite-duration electromagnetic radiation "pulse" are considered. The condition is obtained of validity of the transition matrix element expansion in powers of the perturbation inducing the transition. (auth)

16802 REMARKABLE PROPERTIES OF THE EIKONAL APPROXIMATION. Byron, F. W. Jr. (Univ. of Massachusetts, Amherst); Joachain, C. J. Physica; 66: No. 1, 33-42(15 May 1973).

The relation between the eikonal approximation and the Born series is discussed, and it is shown that a reassessment of the conditions of validity of the eikonal approximation is necessary for a large class of interaction potentials. (auth)

16803 SINGULAR CORES IN THE THREE-BODY PROBLEM. I. THEORY. Brayshaw, D. D. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. D 7: No. 6, 1835-1849 (15 Mar 1973).

The three-body formalism for singular cores previously introduced by the author is considered in some detail. A new derivation is presented which clearly demonstrates the uniqueness of this formalism and clarifies its relationship to appropriate boundary conditions on the three-body wave function. It is shown that an auxiliary boundary condition must be imposed to uniquely specify a solution; this leads to an integral equation with a square-integrable kernel. A detailed proof of three-particle unitarity is given for the amplitudes defined by this equation, and explicit formulas are presented for a representative model. (auth)

16804 FIXED POLES AND OPERATOR SCHWINGER TERMS. Sen, Siddhartha (School of Mathematics, Trinity College, Dublin 2, Ireland). Phys. Rev. D 7: No. 6, 1941-1945 (15 Mar 1973).

By assuming that it is possible to go from the Regge limit ($\nu \to \infty$, q^2 fixed) to the Bjorken-Johnson-Low limit ($q_0 \to \infty$, $|\vec{q}|$ fixed) by making $q^2 - q_0^2$ in the frame $\vec{p}=0$ in the Regge limit, a connection between fixed-pole residues and operator Schwinger terms is established. Comments are made on the electromagnetic mass-shift divergence problem and the Cheng-Tung conjecture regarding the polynomial structure of fixed-pole residues. (auth)

16805 THE ANALYTIC PROPERTIES OF THE BOX DIAGRAM AMPLITUDE: I. Frederiksen, J. S.; Woolcock, W. S. (Research School of Physical Science, The Australian National University, Canberra, A.C.T. 2600). Ann. Phys. (N.Y.) 75: No. 2, 503-544 (Feb 1973).

A double spectral representation of Mandelstam type is obtained for the invariant amplitude T of the binary collision process AB→CD involving scalar particles, using unitarity to evaluate the contribution to Im T from a two-particle intermediate state (EF) and making one-pole approximations to the amplitudes for the processes $AB \to EF$, $CD \to EF$. For the case where the masses satisfy the inequalities $(m_A + m_B \leq (m_E + m_F)\ (m_C + M_D) \leq (m_E + m_F)$ the above approximations are shown to give the same result as that obtained from the Feynman parametrization of the amplitude arising from the box diagram. The proof proceeds by directly evaluating the box diagram amplitude and in this way we obtain a spectral representation of the amplitude for all allowed mass configurations, including cases for which there are anomalous thresholds and cases for which a double spectral representation no longer exists. (auth)

16806 THERE IS NO EFIMOV EFFECT FOR FOUR OR MORE PARTICLES. Amado, R. D.; Greenwood, F. C. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. D 7: No. 8, 2517-2519 (15 Apr 1973).

We show that the existence of a zero-energy (n-1) -body bound state will not produce an infinite number of n-body bound states for $n \geq 4$. We show this in particular for $n=4$, and sketch the proof for $n>4$. (auth)

16807 A DISCRETE VERSION OF THE INVERSE SCATTERING PROBLEM. Case, K. M.; Kac, M. (The Rockefeller University, New York, New York 10021). J. Math. Phys. (N.Y.) 14: No. 5, 594-603 (May 1973).

A discrete version of the inverse scattering problem is considered. The Schrödinger equation with a potential is replaced by a difference equation. The problem is to determine the coefficients given the phase shift. Application is mainly pedagogical. The motivation for the principal steps becomes obvious and the mathematics is elementary. At any stage one can pass, by a limiting procedure, to the usual Schrödinger problem —and reobtain the classical results. (auth)

16808 SLOW-NEUTRON SCATTERING BY A STANDING ELECTROMAGNETIC WAVE. Stassis, C. (Ames Laboratory—U.S. Atomic Energy Commission and Department of Physics, Iowa State University, Ames, Iowa 50010). Phys. Rev. C 7: No. 5, 1926-1929 (May 1973).

We examine the elastic scattering of slow neutrons by a standing electromagnetic wave. It is shown that the real part of the coherent scattering amplitude arises essentially from the interaction of the induced electric dipole moment in the neutron with the electric field of the wave. The imaginary part of the coherent scattering amplitude arises from the interference between the magnetic dipole and spin-orbit interaction terms. (auth)

16809 COMMENTS ON THE CONVERGENCE OF THE RESCATTERING SERIES. Amado, R. D.; Rubin, Morton H. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Rev. C 7: No. 5, 2151-2154 (May 1973).

It is shown that the rescattering series for a multichannel process cannot converge only in a part of phase space. Hence recent fits to the quasifree peak in p-d breakup at intermediate energies are fortuitous. We also discuss the case of slowly convergent rescattering series and of general methods of generating convergent effective rescattering series. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

Refer also to abstract 17283.

16810 LIGHT SCATTERING FROM FIRST AND SECOND SOUND NEAR THE λ TRANSITION IN LIQUID He. Winterling, G.; Holmes, F. S.; Greytak, T. J. (Department of Physics, Center for Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. Lett. 30: No. 10, 427-430 (5 Mar 1973).

We have observed the second-sound contribution to the Brillouin spectrum of liquid He^4 near the λ transition at saturated vapor pressure and at 25.1 atm. Its spectral shape is compared with theoretical predictions. We have determined the intensity ratio of second- and first-sound scattering between $10^{-5}°K < T_\lambda - T < 10^{-1}°K$, and we present data on the dispersion and damping of high-frequency first and second sound. (auth)

Superconductivity

Refer also to abstract 17283.

16811 (LA-tr-73-16) EFFECT OF TWIST ON AC LOSS. Furuto, Y.; Ikeda, C.; Meguro, S. I.; Inoue, I. Translation of ac Rosu ni Okeru Tsuisto Koka. 2p. Dep. NTIS $3.00.

To investigate combination current in composite superconducting twist wire, a type of two current model is adopted such that the current inside the superconductor is on the overlap of super electrons and normal electrons and the critical condition equations are derived. The calculation of the twist effect on ac loss is described. Here, a micro approach is taken in which it is calculated from the electric field and the current inside the conductor. (MHR)

16812 INTERFERENCE EFFECTS IN A SUPERCONDUCTING ALUMINUM FILM; VORTEX STRUCTURE AND INTERACTIONS. Fiory, A. T. (Bell Laboratories, Murray Hill, New Jersey 07974). Phys. Rev. B 7: No. 5, 1881-1889 (1 Mar 1973).

Interference transitions are observed in the mixed state of a granular oxygen-doped superconducting aluminum-film when vortex-lattice motion is driven by applying superimposed rf and dc electric currents. An analysis of the properties of the transitions in the small-signal rf resistivity is made according to a recent theory of vortex motion in an inhomogeneous superconductor by Schmid. The theory satisfactorily explains the effect, which is due to the dissipative excitation of vortex-lattice fluctuations. New information on vortex structure and interactions at low magnetic field is obtained. The vortex-lattice shear-constant measurements agree with the theoretical work of Fetter, Hohenberg, and Pincus and of Brandt. A pinning-potential correlation function also comes out of the measurements and its component factors are identified: the structural-defect correlation function and the vortex-free-energy distribution. The maximum in the free-energy density at the vortex axis, which is larger than Ginzburg-Landau-theory predictions, suggests the presence of the core excitations discussed in a recent microscopic theory of vortex structure. (auth)

16813 SUPERCONDUCTIVITY IN $PB_{0.9}BI_{0.1}$. Vashishta, P. (Argonne National Laboratory, Argonne, Illinois 60439); Carbotte, J. P. Phys. Rev. B 7: No. 5, 1874-1880 (1 Mar 1973).

We present results of strong-coupling calculations of the superconducting properties of the alloy $Pb_{0.9}Bi_{0.1}$. The kernels in the Eliashberg equations are taken from quasiparticle-tunneling data which has been inverted by Dynes according to the method of McMillan and Rowell. The finite-temperature gap equations are solved by successive iteration to obtain solutions at several temperatures. The solutions are then employed to calculate select thermodynamic properties of $Pb_{0.9}Bi_{0.1}$. (auth)

16814 SUPERCONDUCTING ENERGY GAPS FROM MAGNETIZATION MEASUREMENTS: Pb-In SYSTEM. Rao, C. T.; Dubeck, L. W. (Physics Department, Temple University, Philadelphia, Pennsylvania 19122); Rothwarf, F. Phys. Rev. B 7: No. 5, 1866-1874 (1 Mar 1973).

Isothermal-magnetization data have been obtained for a series of well-annealed chrome-plated Pb-In alloys of In composition between 30 and 80 at.% in the temperature range 1.90 °K to the appropriate transition temperature. The empirical relation proposed by Toxen involving the thermodynamic-critical-field data and the energy gap has been found to be valid over a wide range of values of the Ginzburg-Landau parameter κ, the electron mean free path l, and for both weak- and strong-coupling alloys. Consequently, it may be used to obtain the energy gap at T=0 from the critical-field measurements both in the case of elemental and alloy superconductors. The experimentally determined Ginzburg-Landau parameters $\kappa_1(T)$ and $\kappa_2(T)$ show a stronger temperature dependence and are generally larger than predicted by existing weak-coupling theories. (auth)

16815 KINETICS OF FLUX JUMPS IN TYPE-II SUPERCONDUCTORS. Harrison, R. B.; Wright, L. S. (Royal Military College of Canada, Kingston, Ontario, Canada); Wertheimer, M. R. Phys. Rev. B 7: No. 5, 1864-1866 (1 Mar 1973).

Magneto-optic techniques coupled with high-speed cinematography have been used to study the kinetics of flux jumps in type-II superconducting disk samples. The time dependence of the distance of advance (penetration) of the flux front from the point of origin of the jump is shown to be well described by an equation of the form $Z=Z_\infty(1-e^{-t/\tau})$. This correspondence strongly suggests that flux motion during a "runaway instability," at least under these experimental conditions, can be more accurately explained in terms of viscous damping than by a diffusion law. If the flux-jump volume is simulated by a short cylindrical conductor, a time constant can be calculated for the LR circuit analogue. The time constants calculated from this rather crude model compare favorably with experimentally measured values of τ for a large range of sample materials and geometries. (auth)

16816 SUPERCONDUCTIVITY, FERROELECTRICITY, AND THE MOTT INSULATOR. Bari, Robert A. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. B 7: No. 5, 2128-2132 (1 Mar 1973).

It is shown that the Mott-insulator (or semiconductor) state can become unstable to the formation of Cooper pairs. The transition between the states can be either first or second order. The ferroelectric instability of the Mott insulator is also discussed and a spin-analog model is presented that can account for all three thermodynamic states. (auth)

16817 FLUXON COUPLING IN DUAL THIN FILMS. Sherrill, Max D. (Physics Department, Clemson University, Clemson, South Carolina 29631). Phys. Rev. B 7: No. 5, 1908-1912 (1 Mar 1973).

The coupling force for an isolated fluxon which extends through two thin films is calculated in the thin-film approximation. When the distance between centers of the fluxon in the two films is R, the force of attraction is $F_c = (\phi_0/\mu_0)[d_1d_2/(d_1\lambda_2^2 + d_2\lambda_1^2)]A_{d/\lambda^2}(R)$; $A_{d/\lambda^2}(R)$ is the vector potential describing the magnetic field distribution of a fluxon in a film for which d/λ^2 has the effective value $(d_1\lambda_2^2 + d_2\lambda_1^2)/\lambda_1^2\lambda_2^2$. The film thicknesses are d_1 and d_2, the penetration depths are λ_1 and λ_2, and ϕ_0 is the flux quantum. The result is obtained by using a simple superposition principle, and is valid when $d_1 \ll \lambda_1$, $d_2 \ll \lambda_2$, the fluxon core radii are much less than $2\lambda^2/d$, and the separation between the films is small compared to λ_1 or λ_2. (auth)

16818 CRITICAL FLUCTUATIONS IN SUPERCONDUCTORS: A FUNCTIONAL-INTEGRAL APPROACH. Hassing, R. F.; Wilkins, J. W. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14850). Phys. Rev. B 7: No. 5, 1890-1907 (1 Mar 1973).

Using the functional-integral method applied to the BCS Hamiltonian we have calculated the partition function, off-diagonal correlation function, specfic heat, and conductivity of a superconductor in the transition region. The partition function is obtained in the form $\int D\psi \exp(-\beta F[\psi])$, where F is of the Ginzburg-Landau form but with a time-dependent order parameter. An examination of the coefficient, b of the fourth-order term in F, however, shows that b is sharply peaked at zero frequency, thus justifying the use of a time-independent order parameter. We then apply a self-consistent mean-field approximation similar to that of Marčelja to the fourth-order term. The self-consistency condition determines the mean-square fluctuation in the order parameter and a renormalized temperature shift in terms of which the nature of the phase transition (or lack of it) can be understood. We find that only in three dimensions does a phase transition strictly occur, at a slightly lowered transition temperature with critical indices $\gamma=2$, $\nu=1$. In two, one, and zero dimensions the mean-square fluctuation in the order parameter is bounded for $T>0$ and the mean value of the order parameter vanishes, indicating that the transition is completely suppressed in samples of reduced dimensionality. This behavior is reflected in the off-diagonal correlation function which manifests off-diagonal long-range order three dimensions. The specific heat in three dimensions is found to be finite at T_c, with critical index $\alpha=-1$. In two, one, and zero dimensions the specific-heat transition is rounded relative to the BCS result. We find an anomalous factor of 2 in the specific-heat calculation deriving from our treatment of the fourth-order term in F. As a result we conjecture that the Hartree approximation of Marčelja may be better than the Hartree-Fock approximation of Tucker and Halperin. The equations for the conductivity are identical to those of Marčelja. (auth)

16819 MAGNETIC RESONANCE OF A LOCALIZED MAGNETIC MOMENT IN THE SUPERCONDUCTING STATE: $LaRu_2$: Gd. Rettori, C.; Davidov, D.; Chalkin, P.; Orbach, R. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. Lett. 30: No. 10, 437-440 (5 Mar 1973).

The magnetic resonance of dilute $LaRu_2$:Gd has been observed in both the superconducting and normal states. A reduction in the g shift and an increase in the thermal broadening were observed, upon going from the normal to the superconducting regime. The spin–orbit scattering rate, $1/\tau_{s.o.}$, is estimated from both EPR and the re-entrant behavior of the upper critical field in $LaRu_2$:Gd. (auth)

16820 ANNEALING, LONG RANGE ORDER, AND SUPERCONDUCTING TRANSITION TEMPERATURE IN THE V_3Ga A-15 COMPOUND. Koch, C. C. (Oak Ridge National Lab., TN). J. Phys. Chem. Solids; 34: No. 8, 1445-1448(Aug 1973).

It is stated that low-temperature anneals raise the transition temperature in A-15 compounds, presumably by perfecting the degree of long-range order in the A-15 structure. X-ray measurements have shown correlations between increases in T_c and S, the Bragg–Williams long-range order parameter, for a large number of A-15 type superconductors. However, no study is known of the T_c enhancement and the degree of order for V_3Ga, one of the two commercially available high-field A-15 superconductors. The present note discusses an attempt to correlate changes in T_c with x-ray measurements on several A-15 V-Ga alloys. The optimum annealing temperatures for times of approximately 1 week are 600 to 650°C, and increase the T_c by ~1.5K to values approaching 15.5K. (UK)

16821 CRITICAL THICKNESSES IN SUPERCONDUCTING THIN FILMS. Dolan, G. J.; Silcox, J. (School of Applied and Engineering Physics, and Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14850). Phys. Rev. Lett. 30: No. 13, 603-606 (26 Mar 1973).

Direct observations of the magnetic-field distribution in thin films of Pb, Sn, and In indicate that the critical thicknesses separating intermediate-state and mixed-state behavior in these systems are accurately given by theoretical calculations and are much lower than has been believed on the basis of critical-field measurements. (auth)

16822 ANOMALOUS ULTRASONIC ATTENUATION IN PURE SUPERCONDUCTING Nb. Carsey, Frank (National Oceanics and Atmospherics Administration, Wave Propagation Laboratory, Boulder, Colorado 80302); Levy, Moisés. Phys. Rev. B 7: No. 9, 4123-4131 (1 May 1973).

Pure-state data are presented for ultrasonic attenuation in clean Nb (resistivity ratio ≈ 7000) in the domain $0.4 < ql < 6$, where $q = 2\pi/\lambda$ is the phonon wave vector for phonons of wavelength λ and l is the electronic mean free path. These results are presented in light of the models of Fate and Trivisonno, Lacy and Daniel, and Maki. In general, no model is found completely adequate. (auth)

16823 EFFECT OF METALLURGICAL HISTORY ON CRITICAL CURRENT DENSITY IN NbTi ALLOYS. McInturff, A. D.; Chase, G. G. (Atomics International, Division of North American Rockwell Corporation, Canoga Park, California 91303). J. Appl. Phys. 44: No. 5, 2378-2384 (May 1973).

Data are presented describing critical current density J_c as a function of H_a, applied magnetic field, for NbTi alloys containing between 22 and 38 at.% Nb. The effect on $J_c(H_a)$ of precipitation heat treatments between 275 and 565 °C was studied in conjunction with cold area reductions up to 99.9%. The highest critical current densities, $J_c(H_a)$, were in the range 1.0 to 3.6×10^5 A/cm² at 3.0 T where most of the data were obtained. Critical temperature data are presented as a function of alloy composition and metallurgical preparation. (auth)

16824 MEASUREMENT OF CRITICAL BULK AND SURFACE CURRENT DENSITIES IN TYPE-II SUPERCONDUCTORS IN THE MIXED STATE. Kroeger, D. M.; Koch, C. C.; Coghlan, W. A. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). J. Appl. Phys. 44: No. 5, 2391-2396 (May 1973).

We present an improved method for calculating from ac susceptibility measurements the critical current density J_c and the surface shielding parameter ΔH in bulk cylindrical type-II superconductors. As first developed by Bean, the method involves harmonic analysis of an expression for the voltage induced in a pickup coil around a specimen in an axial dc magnetic field with a small ac ripple field superimposed. Values of J_c obtained by Bean's analysis are suspect, in part because the analysis does not take account of surface shielding. Ullmaier modified Bean's calculation to remedy this defect. For simplicity he did not Fourier analyze the induced voltage, choosing instead to determine J_c and ΔH by comparing experimental waveforms with his calculated voltage. This procedure permits only a qualitative indication of whether the data are consistent with the model. For generality, we have modified Ullmaier's calculation by removing the approximation that the depth of penetration of the ac field is small compared to the sample radius. The resulting expression for the induced voltage V is a complicated function of J_c, ΔH, and the amplitude of the ripple field h_o. A graphical procedure has been developed which not only extracts values of J_c and ΔH from plots of the amplitude of the third harmonic of V vs h_o, but also provides a check for consistency of the data with the model. (auth)

16825 CRITICAL MAGNETIC FIELD AND ENERGY-GAP ANISOTROPY OF ZINC. Gubser, D. U.; Cox, J. E. (U.S. Naval Research Laboratory, Washington, D.C. 20390). Phys. Rev. B 7: No. 9, 4118-4123 (1 May 1973).

The critical-magnetic-field curve of a single crystal of Zn has been determined from isothermal dc magnetization measurements over the temperature range from the superconducting transition temperature $T_0 = 0.850$ to 0.013 K. Values of the quantities T_0; H_0, the zero-temperature critical magnetic field; γ, the coefficient of the normal-state electronic specific heat; and $(dH_c/dT)_{T=T0}$, the initial slope of the critical-magnetic-field curve, are given for pure Zn. These values were obtained from the single-crystal data which were corrected to include the effects of a slight amount (0.5 ppm) of Mn impurity. The shape of the critical-magnetic-field curve shows that Zn is a weak-coupling superconductor having a mean-squared energy-gap anisotropy parameter, $\langle a^2 \rangle$, of 0.03. This value of $\langle a^2 \rangle$ is significantly lower than previoulsy believed. (auth)

16826 FLUCTUATION EFFECTS IN SUPERCONDUCTING FILMS. Smith, J. M.; Strandberg, M. W. P. (Department of Physics and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). J. Appl. Phys. 44: No. 5, 2365-2370 (May 1973).

The electrical noise properties of superconducting films in a perpendicular magnetic field have been investigated. Tin films were used, and the dominant source of noise was found to be a flux-flow mechanism. Coherent voltage pulses were also detected in some of these films, but the exact origin of these pulses is unknown. (auth)

16827 CURRENT-INDUCED INTERMEDIATE STATE IN THIN-FILM TYPE-I SUPERCONDUCTORS: ELECTRICAL RESISTANCE AND NOISE. Huebener, R. P.; Gallus, D. E. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. B 7: No. 9, 4089-4099 (1 May 1973).

We have investigated the current-induced resistive state in superconducting strips of lead and indium carrying electrical transport currents with an average density up to 10^6 A/cm². Following previous high-resolution magneto-optical experiments, we report here measurements of the electrical resistance and the electrical-noise-power spectra. The experiments were performed in zero external magnetic field, using micro-strips 60–300μm wide, 0.3–10 μm thick, and 3–6 mm long. In lead, resistive voltage steps were usually observed during variation of the current resulting in pronounced peaks of the derivative $\partial V/\partial I$. These voltage steps are caused by the abrupt creation of channels of normal phase at distinct levels of the transport current. The abrupt growth of these channels of normal phase apparently results from a magnetic instability similar to the kink instability in magnetohydrodynamics. In indium, a step structure in the resistive voltage has been observed only close to T_c, the voltage steps being usually smeared out by fluctuations in time of the number of current-generated channels of normal phase. From the magnitude of the resistive voltage steps and from the observation of dynamic magnetic coupling between two films of a sandwich structure, we conclude that, in the strips of both Pb and In, the current-induced resistive state can best be described by a dynamic model. In this model, the channels of normal phase consist of arrays of flux tubes moving rapidly from the edges to the center of the strip, where they are annihilated by flux tube arrays of opposite sign. The noise-power spectra in the current-induced resistive state usually show a frequency dependence ranging from ω^{-1} to ω^{-2} behavior. The electrical-noise data are discussed in terms of a model assuming fluctuations in time of the number of channels of normal phase. (auth)

16828 ISOTOPE EFFECT IN SUPERCONDUCTING γ-URANIUM ALLOYS. Lindsay, J. D.; White, R. W.; Tinkle, M. C.; Hayter, S. W.; Fowler, R. D. (Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico 87544). Phys. Rev. B 7: No. 9, 4290-4291 (1 May 1973).

A new determination of the isotope effect in γ-stabilized uranium–molybdenum alloys has been made. We find $T_c \propto M^{-0.40}$, rather than the previously reported $T_c \propto M^{-0.53}$. (auth)

16829 DEPENDENCE OF THE THERMAL CONDUCITIVITY ON THE DIRECTION OF THE MAGNETIC FIELD IN SUPERCONDUCTING FILMS WITHOUT VORTICES. Lindenfeld, P.; McConnell, R. D.; Moskowitz, M. S. (Department of Physics, Rutgers University, New Brunswick, New Jersey 08903). Phys. Rev. B 7: No. 9, 4111-4118 (1 May 1973).

We have measured the thermal conductivity of indium and indium–alloy films as a function of magnetic field, with the field

direction in the plane of the specimen, both parallel and perpendicular to the heat flow. The films are either too pure or too thin to contain vortices. In films with short mean free path, the thermal conductivity is less when the field is parallel to the heat current, in contrast to the situation when vortices are present. The magnitude of the anisotropy is consistent with calculations by Maki but the variation with magnetic field and with electronic mean free path is quite different. (auth)

Equipment and Devices

Refer also to abstract 17753.

16830 JOSEPHSON EFFECTS AT HIGH CURRENT DENSITY. Notarys, H. A.; Yu, M. L.; Mercereau, J. E. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. Lett. 30: No. 16, 743-746 (16 Apr 1973).

Effects of large phase gradients on the Josephson relation have been estimated by a modification of the Aslamazov–Larkin theory. The results are applied to explain the Dayem–Wyatt effect. (auth)

16831 AC LOSSES IN SUPERCONDUCTING MAGNET SUSPENSIONS FOR HIGH-SPEED TRANSPORTATION. Tinkham, M. (Department of Physics and Division of Engineering and Applied Physics, Harvard University, Cambridge, Massachusetts 02138). J. Appl. Phys. 44: No. 5, 2385-2390 (May 1973).

A rather general relation is derived between vertical accelerations of the train and cryogenic power dissipation due to ac currents induced in the superconducting suspension magnets. Our theoretical results account for the order of magnitude of the rather large losses observed in the Fuji Electric test vehicle, which used less than state-of-the-art conductors. Even with parameters estimated to represent the best commercially available materials, however, it appears that these losses may be comparable with the total heat leak due to all other causes if the accelerations are as large as permitted by subjective human ride quality considerations. Empirical data on losses under appropriate conditions of B, $\dot{B}$, and I/I_c may be needed to ascertain whether improved materials will be required to avoid serious design constraints by cryogenic heating. (auth)

16832 ANALOG-COMPUTER STUDIES OF MIXING AND PARAMETRIC EFFECTS IN JOSEPHSON JUNCTIONS. Hamilton, C. A. (Quantum Electronics Division, National Bureau of Standards, Boulder, Colorado 80302). J. Appl. Phys. 44: No. 5, 2371-2377 (May 1973).

Analog-computer studies are made on a variety of mixing and parametric effects in Josephson junctions. The predictions of the constant-voltage model are compared with the more general behavior of a junction in a resistive circuit. A simple approximate method is developed for calculating frequency conversion efficiency and the matching condition for a junction operating in the oscillator mixer mode. A similar calculation is made for the second mode of operation, in which an external local oscillator is used. In either of these modes, frequency conversion gain is possible even in a purely resistive circuit. The conditions for parametric amplification without frequency conversion are also studied and it is found that gain occurs only when the self-oscillation frequency is near the signal frequency. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 17258, 17260, and 17261.

16833 (AEEW-M-1201) CY-LEAP: A SYSTEM OF COMPUTER CODES FOR CALCULATING THE SCATTERING LAW FOR AN ANISOTROPIC MATERIAL. Butland, A. T. D. (Atomic Energy Establishment, Winfrith (England)). Jun 1973. 15p. Dep. NTIS (U. S. Sales Only) $3.00.

Three computer codes, including the Harwell codes LEAP and ADDELT are described, which combine to calculate the scattering law for a cylindrically anisotropic material such as graphite. A brief description of the theory is given, and the data input and output are specified for each code. (auth)

16834 (CEA-N-1610) APOLLO: A MULTIGROUP CODE FOR THE SOLUTION OF THE TRANSPORT EQUATION FOR THERMAL AND FAST NEUTRONS. Hoffmann, A.; Jeanpierre, F.; Kavenoky, A.; Livolant, M.; Lorain, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1973. 72p. (In French). Dep. NTIS (U. S. Sales Only) $5.75.

The code APOLLO calculates the flux (direct or adjoint) as a function of energy and space for a one-dimensional medium, while solving the integral transport equation in the multigroup approximation. It also permits the treatment of severe cells in the multicell approximation. APOLLO can treat plane, cylindrical or spherical problems and take into account the anisotropic scattering; it can also compute the diffusion coefficient and the material buckling. APOLLO was designed to be used with any multigroup library; however, two libraries have been generated for APOLLO, one with 186 groups, the other with 99 groups; the UKNDL tape or the ENDF/B III tape can also be used as the origin of the microscopic cross section library. APOLLO uses a new technique for the treatment of self-shielding: it computes the asymptotic equivalent cross section and the Bell factor. Another option of APOLLO is to perform depletion calculations, decay chains being defined for heavy nuclides and fission products. APOLLO can print, punch or plot the flux and compute any reaction rate required; it can also determine the macroscopic data for a reactor diffusion-calculation. (auth)

16835 (KFKI-73-2) ICL VERSION OF THE O5R PROGRAM SYSTEM. Lux, I.; Koblinger, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Nov 1972. 55p. Dep. NTIS (U. S. Sales Only) $4.75.

The well-known O5R (Oak Ridge Random Research Reactor Routine) code was adapted for the computer ICL-1905 of the Central Research Institute for Physics, Budapest. The code is divided into 3 individual parts. This report contains short descriptions and user's manuals of all the three programs. (8 figures) (auth)

16836 (JAERI-M-5033) ENERGY DISTRIBUTIONS OF NEUTRONS SCATTERED FROM KHF_2, $(NH_4)_2SO_4$, AND POLYETHYLENE BY NEUTRON ENERGY-LOSS METHOD. Sakamoto, M.; Iizumi, M.; Motohashi, H. (Japan Atomic Energy Research Inst., Tokyo). Oct 1972. 14p. NTIS (U. S. Sales Only).

Energy distributions of neutrons scattered from KHF_2, $(NH_4)_2SO_4$ and polyethylene at room temperature were measured over the range of energy transfer up to about 250 MeV, using a two-axis crystal spectrometer with beryllium-filter-detector in the JRR-3 reactor. For KHF_2, the peak at 170 MeV involves the contributions from the bending and antisymmetric stretching vibrations, and the peak at 32 MeV corresponds to the acoustical vibration. For $(NH_4)_2SO_4$ there are two peaks at 42 and 29 MeV, which might be due to the torsional and translational motions of ammonium ions. The spectra on polyethylene are discussed in relation to the frequency distributions of normal modes. Based on these results some of the improvements on the experimental set up are discussed. (auth)

16837 MEASUREMENT OF STEADY-STATE, SPACE-DEPENDENT THERMAL NEUTRON SPECTRA IN BERYLLIUM. Lake, J. A. (Atlanta; Georgia Inst. of Tech. (1972)). 297p. University Microfilms Order No. 73-14,080.

Thesis (Ph. D.).

Space-dependent angular thermal-neutron spectra were measured along the longitudinal axes of $25.4 \times 25.4 \times 50.8$ and 35.6×50.8 cm^{-3} beryllium assemblies by the neutron chopper, time-of-flight technique with a thermal column. The spectra for neutrons moving away from the source were characterized by a progressive build-up of cold neutrons, below the Bragg cut-off, with increasing distance from the source plane, the relative rate of cold neutron build-up increasing with increasing transverse buckling (decreasing transverse dimensions). In both assemblies, the angular spectrum was found to be strongly space dependent, and in neither was there any apparent tendency toward an equilibrium or asymptotic distribution out to distances in excess of 40 cm from the source plane. The strong space-dependent behavior means that the usual assumption of space-energy separability in the solution of the transport equation is clearly invalid in this buckling range. Furthermore, the complete lack of equilibrium, asymptotic decay conditions means that the coefficients of the usual fit to the decay constant versus buckling expansion are no longer a unique function of the moderator diffusion parameters. The measured nonequilibrium spatial decay behavior in small beryllium assemblies is in agreement with the published transport theory predictions of the "critical" transverse dimensions for the disappearance of the discrete asymptotic decay mode, but in disagreement with the corresponding diffusion theory results which predict that asymptotic decay conditions should exist in beryllium assemblies as small as 30×30 cm^2. (RWR)

16838 AZIMUTHALLY DEPENDENT NEUTRON TRANSPORT IN SLAB GEOMETRY. Hill, T. R. Manhattan, KS; Kansas State Univ. (1972). 186p. University Microfilms Order No. 73-13,349.

Thesis (Ph. D.).

The azimuthal dependence of neutron transport in plane geometry is treated by a Fourier decomposition technique. The solution to the slab albedo problem is obtained by expansion of the azimuthal dependence of the angular flux in an indefinite Fourier cosine series. A finite set of uncoupled, azimuthally symmetric slab albedo problems result. The Fourier coefficients of the angular flux are shown to satisfy a modified transport equation, similar in form to the standard azimuthally symmetric transport equation. As a consequence of this similarity, the customary methods for the analysis of slab geometry transport problems are applied to the modified transport equation. The properties of the azimuthal modes are investigated by the singular eigenfunction expansion technique. The discrete eigenvalue spectrum is calculated for both a forward-peaked and a backward-peaked scattering function. It is shown that the discrete ordinates transport code ANISN can be applied without major modifications to the numerical calculation of the azimuthal modes. Several computational problems encountered in the calculation of the Fourier modes are resolved. The applicability of alternate approximation methods, such as invariant imbedding, is examined. The results of a set of one-group calculations are presented to provide a basic understanding of the behavior of the azimuthal modes. The one-angle or azimuthally symmetric mode approximation is found to be, in general, inadequate. The use of a truncated Fourier-expansion approximation to the angular flux is inaccurate for large scattering angles of the source neutrons. A five-group slab albedo calculation indicates the energy spectrum to have a significant azimuthal dependence. Finally, a comparison between an experimental spectrum and a ten-group calculated spectrum from an azimuthally dependent transmission experiment for a steel slab is given. (RWR)

16839 FINITE ELEMENTS VERSUS FINITE DIFFERENCES. A Comparison of Two Methods for the Solution of the Diffusion Equation. Schmidt, F. A. R.; Franke, H. P. (Univ., Stuttgart). Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1973). vp. (In German).

From reactor meeting; Karlsruhe, Germany (10 Apr 1973).

In a simple test example the difficulties and advantages of the finite element method are investigated and compared with the method of finite differences. (1 figure, 2 tables) (GE)

16840 TENSORIAL FORMULATION OF NEUTRON DIFFUSION THEORY. Boffi, V. C. (Univ., Bologna); Trombetti, T. Meccanica; 7; 131-140(Sep 1972).

A tensorial formulation of monoenergetic neutron diffusion theory is presented as can be derived starting from the integral form of the Boltzmann equation. A result of this tensorial approach is that, as a consequence of a spatial variation of the macroscopic cross sections or of the finite dimensions of the body under examination, the diffusion coefficient is no longer a constant scalar quantity, but a second order symmetric tensor, whose components are functions of both the position and the properties of the material which composes the body. The components of the diffusion coefficient tensor are explicitly evaluated in the case of some homogeneous convex bodies. (auth)

16841 REFRACTION OF THERMAL NEUTRONS BY SHAPED MAGNETIC FIELDS. Just, W.; Schneider, C. S.; Ciszewski, R.; Shull, C. G. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. B 7: No. 9, 4142-4145 (1 May 1973).

The refractive bending of thermal neutrons by shaped magnetic fields has been studied experimentally and compared with that calculated from the field distribution. The small deflections, a few seconds arc, were measured on a double-crystal spectrometer utilizing matched perfect silicon crystals. Deflections were measured for a beam of polarized neutrons upon its polarization reversal for field regions of both prismatic and cylindrical configuration. The focusing and polarizing character of a magnetic lens have been observed. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 16530, 16760, 16809, 16884, 16913, 16970, 17092, 17099, and 17102.

16842 (BMFT-FBK-73-2, pp 5-6) FINAL-STATE INTERACTION AND QUASI-FREE SCATTERING IN THE D(p,2p)n REACTION WITH E_p = 16 MeV. Klein, H. Mar 1973. (In German).

16843 (BMFT-FBK-73-2, pp 33-35) DETERMINATION OF THE ABSOLUTE DIFFERENTIAL $\alpha-\alpha$ SCATTERING CROSS SECTION FOR E = 23.805 MeV. Nagel, W.; Stehle, H. Mar 1973. (In German).

16844 (BMFT-FBK-73-2, pp 126-128) DETERMINATION OF THE BINDING ENERGY OF THE DEUTERON BY WAY OF THE $^1H(n,\gamma)^2D$ REACTION. Schuette, M. Mar 1973. (In German).

16845 (JINR-D-6840, pp 352-361) DISPERSION CALCULATION OF THE REAL PART OF THE FORWARD πHe^4 ELASTIC SCATTERING AMPLITUDE. Dubnicka, S. (Joint Inst. for Nuclear Research, Dubna, USSR). 1973.

From 2nd symposium on high energy and elementary particle physics; Strbske Pleso, Czechoslovakia (3 Oct 1972).

The calculation of the Re f (ω), where ω is the total energy of the pion in the lab system, for the process $\pi + {}^4He \rightarrow \pi + {}^4He$ is analyzed in detail from the forward dispersion relation. The most probable cause why it was not possible to obtain a satisfactory consistency between the experimental data of Re f (ω) and the total cross section through the forward dispersion relations is found. (JFP)

16846 MICROSCOPIC TREATMENT OF THE COUPLED MONOPOLE AND QUADRUPOLE VIBRATIONS IN LIGHT NUCLEI. Caurier, E. (Centre de Recherches Nucleaires de Strasbourg); Bourotte-Bilwes, B.; Abgrall, Y. Phys. Lett.; 44B: No. 5, 411-415(28 May 1973).

The coupled monopole and volume-conserving quadrupole oscillations in ^4He, ^{12}C, ^{16}O, ^{20}Ne and ^{40}Ca were studied within the framework of the Hill-Wheeler generator coordinate method. (auth)

16847 EFFECT OF ISOBAR CONFIGURATIONS ON THE PHOTODISINTEGRATION OF THE DEUTERON. Miller, H. G.; Arenhövel, H. (Abteilung für Kernphysik, Max-Planck-Institut für Chemie, Mainz, W. Germany). Phys. Rev. C 7: No. 3, 1003-1005 (Mar 1973).

A nonrelativistic calculation of the photodisintegration of the deuteron below pion threshold has been completed in which nuclear polarization effects described by isobar configurations (NΔ and $\Delta\Delta$) have been included. At lower energies ($E_\gamma^{lab} \leq 40$ MeV) the inclusion of these isobar configurations leads to an over-all decrease of the total cross section and the proton angular distribution due to renormalization of the normal deuteron components. At higher energies the total cross section is enhanced (up to 5% at $E^{lab}{}_\gamma = 120$ MeV) and the proton angular distributions are more forward peaked. These results lead to better agreement with experiment. (auth)

16848 SENSITIVITY OF LOW-ENERGY THREE-BODY PROPERTIES TO THE OFF-SHELL TWO-BODY T-MATRIX. Lavine, J. P.; Mukhopadhyay, S. K.; Stephenson, G. J. Jr. (Department of Physics and Astronomy, and Center for Theoretical Physics, University of Maryland, College Park, Maryland 20742). Phys. Rev. C 7: No. 3, 968-973 (Mar 1973).

Direct modifications are made to the off-shell two-body t matrices which are used as input to the Faddeev-Lovelace equations for the three-body bound state and for scattering below breakup. The t matrices are modified when either momentum argument exceeds a particular value, in a manner which will maintain off-shell unitarity when it is important. In this way, we are able to test the dependence of these three-body properties on different regions of the off-shell momenta. We find a strong sensitivity for both momenta less than 2 fm^{-1}; weak, potential-dependent sensitivity when either argument is between 2 and 5 fm^{-1}, and essentially no dependence if either argument exceeds 5 fm^{-1}. (auth)

16849 ANGULAR DISTRIBUTIONS AND ABSOLUTE CROSS SECTIONS FOR THE T(d,n)^{4}He NEUTRON-SOURCE REACTION. McDaniels, D. K.; Drosg, M.; Hopkins, J. C.; Seagrave, J. D. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 7: No. 3, 882-888 (Mar 1973).

The T(d,n)^{4}He neutron-source reaction has been reinvestigated utilizing the neutron time-of-flight techniques. This study was motivated by the lack of cross section data above 11 MeV, by large uncertainties in the 0° absolute cross sections, and by the need to improve the accuracy of both the absolute and relative cross-section data. Angular distributions were measured at E_d=5.0, 6.0, 7.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, and 15.7 MeV using a neutron detector with a well-established relative efficiency. Absolute cross sections at 0° were obtained by normalization to precise charged-particle cross sections obtained for the reaction D(t, ^{4}He)n. Below 10 MeV there is good agreement with earlier data. (auth)

16850 DEUTERON INTERACTION CURRENT IN THERMAL n-p CAPTURE. Gari, M.; Huffman, A. H. (California Institute of Technology, Pasadena, California 91109). Phys. Rev. C 7: No. 3, 994-1003 (Mar 1973).

The experimental cross section for radiative n-p capture at thermal energies is 10% larger than the theoretical cross section calculated from the impulse terms (free-nucleon isovector magnetic moment). In the present work the pion-exchange contribution is evaluated using the Chew-Low static model amplitude for the photopion process. We demonstrate how the various pieces of the photopion amplitude contribute to the exchange current. The results for Hamada-Johnston, Reid hard-, and soft-core potentials are 10.5, 10.9, and 11.5% increases, respectively, to the impulse cross section from pion processes. This work verifies the earlier paper of Riska and Brown demonstrating that the 10% discrepancy can be accounted for as a one-pion-interaction effect. (auth)

16851 ANGULAR DISTRIBUTION OF 24.0- AND 27.2-MEV NEUTRONS SCATTERED BY PROTONS. Burrows, Thomas W. (University of Wisconsin, Madison, Wisconsin 53706). Phys. Rev. C 7: No. 4, 1306-1311 (Apr 1973).

Angular distributions for elastic scattering of neutrons by protons were measured with a counter telescope between 71 and 158° (c.m.) for neutron energies of 24.0 and 27.2 MeV. The angular distributions agreed with the distributions predicted by Hopkins and Breit. The measured anisotropies, $[\sigma(180°)/\sigma(90°)]-1$, were 0.135 ± 0.014 and 0.183 ± 0.015 at 24.0 and 27.2 MeV, respectively. (auth)

16852 FURTHER NEUTRON-PROTON BREMSSTRAHLUNG RESULTS. Brady, F. P. (Croker Nuclear Laboratory and Department of Physics, University of California, Davis, California 95616); Young, J. C. Phys. Rev. C 7: No. 4, 1707-1708 (Apr 1973).

Neutron-proton bremsstrahlung calculations predict cross sections integrated over the photon angle, Θ_γ, which show rather modest model dependence. However, the predicted photon angular distributions manifest a large model dependence. Unpublished data from a previous experiment were integrated over positive and negative photon angles, and the ratio compared with model predictions. The results are that the potential model calculations of Brown and Franklin were favored. (auth)

16853 NUCLEON-ALPHA ELASTIC SCATTERING ANALYSES. II. 0 to 21 MeV Energy-Dependent n-α ANALYSIS. Arndt, R. A.; Roper, L. D. (Virginia Polytechnic Inst., Blacksburg). Nucl. Phys.; A209: No. 3, 447-460(30 Jul 1973).

An energy-dependent phase-shift analysis of 0 to 21 MeV n-α scattering is presented and compared to the previous 0 to 23 MeV p-α analysis. The error matrix and inverse error matrix for both the n-α and the p-α analyses are given. (auth)

16854 NUCLEON-α ELASTIC SCATTERING ANALYSES. I. Low-Energy n-α and p-α Analyses. Arndt, R. A.; Long, D. D.; Roper, L. D. (Virginia Polytechnic Inst., Blacksburg). Nucl. Phys.; A209: No. 3, 429-446(30 Jul 1973).

Energy-dependent phase-shift analyses of low-energy n-α and p-α elastic scattering data were performed. Effective range parameters were obtained using the least number of parameters, and data up to the lowest energy necessary to give good fits. Fits to data up to 5 MeV for p-α scattering and up to 3 MeV for n-α scattering, with 7 parameters used in each case, were chosen as the optimum low-energy solutions. Examples of observables which can be calculated from these solutions are presented. (auth)

16855 ANGULAR DISTRIBUTIONS IN THE SCATTERING OF PARTICLES WITH SPIN ½ BY NUCLEI WITH SPIN ½. Garcia, R. G. Mexico City; Universidad Nacional Autonoma de Mexico (1973). 65p. (In Spanish).

Thesis.

An adjustment analysis is made of the process parameters of the elastic reaction ^{3}He(p,p)^{3}He, making use of the experimental results of angular distribution given by T. A. Tombrello and the corresponding expression. The character of the adjustment is purely phenomenological to make theory coincide with experiment. The dispersion matrix is first treated with a discussion of its properties of symmetry, unitarity, and independence from the reference system. In order to avoid tedious developments in obtaining the differential cross section for the case of particles with spin, changes of representation of a wave function and the associated operators are discussed. The most general expressions for the cross section and differential cross section are obtained as a function of the dispersion matrix. These general expressions are generalized for the differential cross section in terms of the dispersion amplitudes for the case of spin $\frac{1}{2}$ on $\frac{1}{2}$. The equations obtained were adjusted to the experimental values of the differential cross section of the reaction ^{3}He(p,p)^{3}He. (tr-auth)

16856 RELATIVISTIC CORRECTIONS IN THE NUCLEAR-PLUS-ELECTROMAGNETIC HAMILTONIAN. Liou, M. K.; Sobel, M. I. (Department of Physics and Institute for Nuclear Theory, Brooklyn College of the City University of New York, Brooklyn, New York 11210). Phys. Rev. C 7: No. 5, 2044-2056 (May 1973).

We investigate the problem of relativistic corrections to the Hamiltonian of two nucleons interacting with each other and with an external electromagnetic field. We find, in addition to well-known corrections to the kinetic energy and to the Foldy-Wouthuysen reduction, a correction to the potential energy. This effect depends on the way in which the nonrelativistic limit of the dynamical variables is taken. The correction vanishes in the c.m. system, but leads to a nonzero correction to the electromagnetic Hamiltonian. We define the current and charge densities, verify the conservation of current, and verify the low-energy theorem for bremsstrahlung. (auth)

16857 EVIDENCE FOR A STRONG THREE-BODY FORCE IN THE TRITON. Brayshaw, D. D. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. C 7: No. 5, 1731-1735 (May 1973).

Existing data for the charge form factors of ^{3}He, ^{3}H and some assumptions are employed to construct a model of the triton wave function. Given this wave function, the Schrödinger equation may be trivially solved for the effective local potential. The discrepancy between this potential and those predicted by typical pair-interaction models in the domain where all three particles are close together appears to provide evidence for a strong attractive three-body force. (auth)

16858 EFFECT OF THE SHORT-RANGE PART OF THE NUCLEON-NUCLEON INTERACTION ON THE PROPERTIES OF THE THREE-NUCLEON SYSTEM. Bahethi, O. P.; Fuda, M. G. (Department of Physics and Astronomy, State University of New York, Buffalo, New York 14214). Phys. Rev. C 7: No. 5, 1845-1850 (May 1973).

Some of the low-energy properties of the three-nucleon system are calculated with two s-wave spin-dependent interactions, which produce almost identical $^3S_1$ and $^1S_0$ two-nucleon phase shifts up to a lab energy of 350 MeV. Both interactions consist of an attractive square well and a short-range repulsion. The repulsive part of one potential is a hard core, for the other it is a nonlocal, separable potential. The hard-core potential produces a triton binding energy of 8.7 MeV, a doublet scattering length of 0.84 fm, and a quartet scattering length of 6.30 fm. The corresponding parameters calculated with the partly nonlocal potential are 8.8 MeV, 0.85 fm, and 6.31 fm. These results suggest that the low-energy properties of the three-nucleon system are insensitive to the details of the short-range part of the two-nucleon interaction. (auth)

16859 EXCITED STATES OF ^{4}He AND ^{5}He FROM SEQUENTIAL α + d REACTIONS AT E_α=70 MeV. Treado, P. A.; Lambert, J. M. (Georgetown University and Naval Research Laboratory, Washington, D. C. 20007); Kane, R. J.; Beach, L. A.; Petersen, E. L.; (and others). Phys. Rev. C 7: No. 5, 1742-1750 (May 1973).

The D(α,pd)T and D(α,dt)H sequential reactions through ^{4}He* and ^{5}He* are investigated in a kinematically complete experiment with E_α=70 MeV, particle identification, and on-line computer coincidence electronics. Data analysis of various p-d and d-t coincidence spectra are presented. Sequential decay through the 20.1-, 21.4-, and 22.4-Mev states of ^{4}He and the 16.7-MeV states of ^{5}He are observed. The results are in good agreement with previous work on ^{4}He* and spectral structure due to ^{5}He excited states is suggestive of narrow states of 18.6, 18.8, and 19.2 MeV of excitation. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 16466, 16530, 16753, 16846, 16907, 16909, 16923, 16970, 16999, 17081, 17086, 17088, 17102, and 17120–17122.

16860 (BMFT-FBK-73-2, pp 7-10) QUASI-FREE SCATTERING IN THE REACTION ^{6}Li(α,2α)d. Helten, H. J.; Klein, H. Mar 1973. (In German).

16861 (BMFT-FBK-73-2, pp 10-13) THREE-PARTICLE MEASUREMENTS ON THE ^{9}Be COMPOUND SYSTEM WITH THE REACTION ^{7}Li(d,$\alpha\alpha$)n. Eichner, H. Mar 1973. (In German).

16862 (BMFT-FBK-73-2, pp 15-17) REACTION ^{16}O(α, 2α)$^{12}C_{g.s.}$ AT 24 MeV. Prescher, K.; Eichner, H. Mar 1973. (In German).

16863 (BMFT-FBK-73-2, pp 21-23) (α,γ) EXCITATION FUNCTION OF ^{12}C. Ewen, K.; Gonsior, B. Mar 1973. (In German).

16864 (BMFT-FBK-73-2, pp 23-26) ^{18}F COMPOUND-NUCLEUS REACTIONS ^{14}N(α,n)^{17}F AND ^{16}O(d,n)^{17}F. Burgmer, W.; Gruhle, W.; Schmidt, W. Mar 1973. (In German).

16865 (INP-824) RESONANT STRUCTURES IN THE ELASTIC SCATTERING OF ALPHA PARTICLES ON LIGHT AND MEDIUM WEIGHT NUCLEI. Budzanowski, A.; Chyla, K.; Czabanski, R.; Grotowski, K.; Jarczyk, L.; Kamys, B.; Kapuscik, A.; Micek, S.; Ploskonka, J.; Strzalkowski, A.; Szmider, J.; Wrobel, Z.; Zastawniak, L.; Zybert, R. (Institute of Nuclear Physics, Krakow (Poland)). Dec 1972. 32p. Dep. NTIS (U. S. Sales Only) $3.75.

Excitation functions for the elastic scattering of alpha particles from O, Mg, Al, Si, Ca, Ni, Co, Cu, and Au nuclei at $\Theta_{LAB} = 179°$ were measured in the lab. energy range from 22.75 to 28.40 MeV. The data for light nuclei show a rich structure which may be attributed to some intermediate states. For ^{24}Mg and ^{28}Si possible correlations between (α,α), (α,p), and (p,α) channels are indicated. In the case of Ni, Co, and Cu broad maxima with a width of about 2.5 MeV were found. It was shown that the optical model of interaction is able to reproduce these broad maxima. Examination of the Argand diagrams lead to the conclusion that the maxima observed for medium weight nuclei are formed as a result of a coherent superposition of many partial waves, each of which behaves in an echo-like manner. (auth)

16866 (JINR-P1-7217) CROSS SECTIONS OF INELASTIC INTERACTIONS OF 17 GeV/c α-PARTICLES WITH (C,O) AND (Ag,Br) NUCLEI. Abdo, Kh. M.; Dalkhazhav, N.; Salomov, D. A.; Silesh, E.; Sun Tsin Yan, G. Ya.; Tolstov, K. D.; Totova, M.; Tuchek, L.; Khoshmukhamedov, R. A.; Shabratova, G. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1973. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

Preliminary results for the interaction of 16.8-GeV/c α-particles with C, O and Ag, Br nuclei, are presented: the total cross sections for inelastic interactions $\sigma(\alpha,O)$ = (500 ± 60) mb and $\sigma(\alpha,Ag)$ = (1780 ± 130) mb, inelastic interaction cross sections for the cases where one of the secondary particles was relativistic and doubly charged $\sigma_{\alpha,O}$(^{3}He,^{4}He) = (57 ± 15) mb and $\sigma_{\alpha,Ag}$ (^{3}He,^{4}He) = (205 ± 50) mb; the probability for the total disintegration of nuclei Ag, Br is found to be (0.057 ± 0.013). (auth)

16867 (UR-3055-5) MEASUREMENT OF ^{3}He-^{9}Be NEUTRON SPECTRA AND YIELDS BY PULSED BEAM TIME-OF-FLIGHT TECHNIQUES AND THEIR RADIOBIOLOGICAL APPLICATIONS. Gifford, B. R. (Rochester Univ., N. Y.). 1972. Contract AT(11-1)-3055. 215p. Dep. NTIS $12.75.

Thesis.

The utilization of fast neutrons produced by charged-particle-thick-target reactions in radiation biology and radiotherapy is dependent upon their penetration in tissue relative to ^{60}Co gamma radiation, their oxygen enhancement ratio, their relative biological effectiveness, their fractionation effects, their technological feasibility, and their cost. The first four factors may be reasonably estimated from a knowledge of the neutron energy distribution and yield, while the latter two factors are rapidly becoming lesser barriers as small cyclotrons become readily available to the radiation biologist and radiotherapist. By utilizing the pulsed-beam facility at the University of Rochester's 20-MeV MP tandem accelerator, neutron spectra and yields were measured for ^{3}He beams incident on thick targets of beryllium. The time-of-flight technique was employed to measure neutron energies with the aid of a 3-meter flight path. The detector was a 2.54-cm-thick NE-213 organic scintillator. Pulse shape discrimination was employed to reduce gamma-ray efficiency. The efficiency function of the NE-213 scintillator for neutron energies up to 13 MeV (for five bias levels) and response to protons and electrons were also measured. A semiempirical method for calculating detector efficiencies at arbitrary bias levels was developed. Neutron spectra and yields were measured at 10 angles between 0° and 90° inclusive for 16-, 22-, and 26-MeV

^{3}He beams incident on thick Be targets. Measurements were also taken at 0° for 18-, 20-, and 24-MeV ^{3}He beams. The spectra could all be fitted to the expression $N(E_n)/E_n = K \cdot EXP(E_n/T)$. In a number of cases, two exponential functions were required to fit the neutron energy distribution. The neutron yield as a function of angle could be expressed by the polynomial $Y[E(^3He)] = \Sigma a_n (\cos\theta)^n$, where θ is the laboratory angle. Polynomial expansion coefficients are given for E(^{3}He) = 16, 18, 20, 22, 24 and 26 MeV. (59 figures, 23 tables) (auth)

16868 β-DECAY OF ^{17}N TO UNBOUND STATES OF ^{17}O. De Meijer, R. J.; Delaune, C.; McShan, D.; Nelson, J. W.; Van Rinsvelt, H. A. (Florida State Univ., Tallahassee). Nucl. Phys.; A209: No. 2, 424-428(1973).

The β-decay branching of ^{17}N to unbounded states of ^{17}O was measured. The intensities of the neutron groups from ^{17}O levels at E_x = 4.55, 5.38, and 5.94 MeV result in ^{17}N β^- branching ratios of (27 ± 3), (57 ± 4), and (11 ± 2)%, respectively. The results are compared with the known mirror decay of ^{17}Ne and with shell-model calculations. (2 figures, 1 table) (auth)

16869 CROSS SECTIONS FOR (π, πn) REACTIONS ON ^{14}N AND ^{19}F AT THE (3/2, 3/2) RESONANCE. Karol, P. J.; Caretto, A. A. Jr.; Klobuchar, R. L.; Montgomery, D. M.; Williams, R. A.; Yester, M. V. (Carnegie-Mellon Univ., Pittsburgh). Phys. Lett.; 44B: No. 5, 459-461(28 May 1973).

Neutron knockout cross sections induced by π^+ mesons on ^{14}N and by π^+ and π^- mesons on ^{19}F were measured at 190 MeV relative to ^{12}C. Results are compared to both qualitative and rigorous theoretical models. (auth)

16870 ^{8}LI MAGNETIC DIPOLE MOMENT. Haskell, R. C.; Madansky, L. (Department of Physics, The Johns Hopkins University, Baltimore, Maryland 21218). Phys. Rev. C 7: No. 4, 1277-1279 (Apr 1973).

Polarized ^{8}Li nuclei recoiling from the reaction ^{7}Li(d,p)^{8}Li were implanted in Au, Pd, and Pt foils, and the Knight-shifted values of the ^{8}Li magnetic dipole moment in these metals were measured by a resonant depolarization technique. From measurements of the spin-lattice relaxation times of ^{8}Li implanted in Au, Pd, and Pt, the Knight shifts of ^{8}Li in these metals were estimated. A corrected value for the magnetic dipole moments of ^{8}Li was found to be μ (^{8}Li) = (1.653 35±0.000 35) μ_N. Attempts were also made to measure the quadrupole couplings of ^{8}Li in single crystals of Be and Mg. While the resonance lines could not be distinctly resolved, upper and lower limits have been deduced for $|e^2qQ/h|$ in these two metals. (auth)

16871 EXPERIMENTAL MEASUREMENTS OF THE ^{12}C + ^{12}C NUCLEAR REACTIONS AT LOW ENERGIES. Mazarakis, Michael G.; Stephens, William E. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. C 7: No. 4, 1280-1287 (Apr 1973).

The nuclear reactions ^{12}C(^{12}C,α)^{20}Ne and ^{12}C(^{12}C,p)^{23}Na have been observed from 5-MeV down to 2.45-MeV center-of-mass energy. Angular distributions and energy distributions of the protons and α particles were analyzed to obtain the total cross sections and other nuclear information. The Coulomb and angular momentum barrier penetrability was factored out to elucidate the intermediate resonance structure in the nuclear factor S. The observed rise in the nuclear factor at the lowest energies may be interpreted as "absorption under the barrier" as proposed by Michaud and Vogt. The importance of these reactions for the carbon burning era of nucleosynthesis and energy generation in the later evolution of stars is mentioned and reaction rates are estimated for various burning temperatures. (auth)

16872 COMPOUND SYSTEM FORMATION AT $E_{C.M.}$=36 MEV IN ^{14}N+^{12}C→^{6}Li+^{20}Ne. Belote, T. A.; Anyas-Weiss, N.; Becker, J. A.; Cornell, J. C.; Fisher, P. S.; (and others) (Nuclear Physics Laboratory, Oxford, England). Phys. Rev. Lett. 30: No. 10, 450-453 (5 Mar 1973).

Angular distributions of ^{6}Li produced in the reaction ^{14}N+^{12}C→^{6}Li+^{20}Ne have been measured at a center-of-mass energy of 36 MeV. Data were taken for the reactions ^{12}C(^{14}N, ^{6}Li)^{20}Ne and ^{14}N(^{12}C, ^{6}Li)^{20}Ne in order to cover the complete angular range ($16° \leq \theta_{c.m.} \leq 165°$). The angular distributions are symmetric about $\theta_{c.m.} = 90°$ and closely follow a $(\sin\theta)^{-1}$ dependence. This is interpreted as indicating that the reaction proceeds primarily through compound-nucleus formation. (auth)

16873 COMMENT ON THE SPINS OF THE STATES NEAR 5.4 MeV IN ^{19}O. Donoghue, T. R. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. C 7: No. 3, 1270-1272 (Mar 1973).

A review of the analysis of the n+^{18}O elastic scattering data advances the argument that two states, with $J^\pi = 3/2^+$ and $5/2^+$, are the dominant levels in ^{19}O near 5.4 MeV excitation. Both states show significant single-particle strengths. The $^3/_2^+$ spin assignment is in agreement with the recent shell-model calculations of Halbert et al. The origin of the $^5/_2^+$ state is still open. (auth)

16874 COMMENT ON THE SPIN OF THE 5.46-MeV LEVEL OF ^{19}O. Wiza, J. L.; Fortune, H. T. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. C 7: No. 3, 1267-1269 (Mar 1973).

The neutron width of the unbound 5.46-MeV state in ^{19}O and its strength in the ^{18}O(d,p)^{19}O reaction are consistent only with $J^\pi = 3/2^+$. (auth)

16875 SHELL-MODEL CALCULATIONS FOR A = 18, 19, AND 20 NUCLEI WITH CORE EXCITATION INCLUDED EXPLICITLY. McGrory, J. B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Wildenthal, B. H. Phys. Rev. C 7: No. 3, 974-993 (Mar 1973).

Eigenvalues and eigenvectors for all low-lying positive- and negative-parity nuclear states of A = 18, 19, and 20 are calculated in a shell-model basis of all Pauli-allowed $0p_{\frac{1}{2}} - 0d_{\frac{3}{2}} - 1s_{\frac{1}{2}}$ configurations outside an inert ^{12}C core. Two different effective Hamiltonians are used. One is based on a reaction matrix treatment of the Hamada–Johnston potential. The second one is obtained by varying the 33 effective Hamiltonian matrix elements to reach a least-squares fit between 153 experimental level energies in nuclei in the A = 13-22 region and the corresponding shell-model eigenvalues. The energy level spectra and single-nucleon spectroscopic factors from these calculations are compared to the available experimental data in this region. The calculations are also examined for the existence and characteristics of sequences of levels which might be called "rotational bands". (auth)

16876 ISOSPIN-FORBIDDEN PARTICLE DECAYS OF T=3/2 LEVELS IN MIRROR NUCLEI. Adelberger, E. G. (California Institute of Technology and Princeton University); McDonald, A. B.; Cocke, C. L.; Davids, C. N.; Shukla, A. P.; (and others). Phys. Rev. C 7: No. 3, 889-916 (Mar 1973).

Absolute branching ratios for the isospin-forbidden particle decays of the lowest T=3/2 levels of ^{13}C, ^{13}N, ^{17}O, and ^{17}F have been measured by populating the levels in (^{3}He,p), (^{3}He,α), or (^{3}He,n) reactions and observing the resulting decay products in coincidence. Branching ratios of 0.070±0.018, 0.261±0.030, and 0.026±0.018 (0.236±0.012, 0.150±0.010, 0.053±0.015) were determined for the neutron (proton) decays of the 15.1-MeV, T=3/2 level of ^{13}C (^{13}N) to the ground state and first two excited states of ^{12}C, respectively. Branching ratios of 0.91±0.15 and 0.05±0.02 (0.088±0.016, 0.23±0.05) were determined for the neutron (proton) decays of the 11.08-(11.20-)MeV, T=3/2 level of ^{17}O(^{17}F) to the ground state and unresolved 6.05- and 6.13-MeV excited states of ^{16}O, respectively. The α-decay branching ratios of the 15.1-MeV, T=3/2 level of ^{13}N to the ground state and first two excited states of ^{9}B were determined to be 0.049±0.027, 0.039±0.039, and 0.072±0.045, respectively. Possible origins of the large asymmetries observed in the nucleon decays of these analog levels are discussed. The value obtained for Γ_{p0}/Γ for the lowest T=3/2 level of ^{13}N may be combined with ^{13}C(e,e') and ^{12}C(p,γ)^{13}N measurements to determine the ratio $\Gamma_\gamma^{M1}(^{13}C)/\Gamma_\gamma^{M1}(^{13}N) = 1.0 \pm 0.2$ for γ decay to the ground state. This places an upper limit on the isotensor transition matrix element at 7% of the isovector matrix element. (auth)

16877 TOTAL NEUTRON YIELD FROM THE REACTIONS ^{13}C(α,N)^{16}O AND ^{17,18}O(α,n)^{20,21}Ne. Bair, J. K. Oak Ridge National Laboratory, Oak Ridge, Tennessee, 37830); Haas, F. X. Phys. Rev. C 7: No. 4, 1356-1364 (Apr 1973).

Compound states of high excitation in ^{17}O and ^{21,22}Ne have been observed, with good resolution, in the total neutron yield from the reactions ^{13}C(α,n)^{16}O and ^{17,18}O(α,n)^{20,21}Ne. Bombarding α-particle energies were approximately from 1 to 5 MeV. Analysis of the area under the excitation curves gives α-particle strength functions of $S_\alpha = 0.029 \pm 0.030$ for ^{13}C+α, 0.030 ± 0.023 for ^{17}O+α, and 0.022 ± 0.010 for ^{18}O+α. For astrophysical purposes these strength functions are used to extrapolate the average cross sections to lower energies. (auth)

16878 MULTICHANNEL THREE-BODY MODEL OF ^{6}LI. Chuu, D. S.; Han, C. S.; Lin, D. L. (Department of Physics and Astronomy, State University of New York, Buffalo, New York 14214). Phys. Rev. C 7: No. 4, 1329-1335 (Apr 1973).

The binding energies of the lowest isospin singlet ($J^\pi = 1^+$) and triplet ($J^\pi = 0^+$) states of ^{6}Li are calculated on a multichannel three-body model in which the internal structure of the α particle is approximately represented by a two-state system. The n-α interaction is given by a two-channel l-dependent potential that is obtained by fitting low-energy scattering data. The np interaction is taken to be the Pease-Feshbach potential. The Faddeev equations are generalized to allow spin and internal structure of the particles, and are solved in the separable t-matrix approximation for bound-state energies. The results obtained are in good agreement with experiments. The effect of the α internal structure is discussed. (auth)

16879 ELECTRON SCATTERING FROM ^{19}F AND ^{40}Ca. Hallowell, P. L.; Bertozzi, W.; Heisenberg, J.; Kowalski, S.; Maruyama, X.; (and others) (Laboratory for Nuclear Science and Department of

Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. C 7: No. 4, 1396-1409 (Apr 1973).

Electron scattering form factors were measured for the low-lying levels of ^{19}F and ^{40}Ca for momentum transfers between 0.55 and 1.00 fm^{-1}. Elastic scattering from ^{19}F yields an rms charge radius of 2.885 ± 0.015 fm. Transition strengths and transition radii are obtained for the lowest $5/2^+$, $5/2^-$, and $3/2^+$ states in ^{19}F. A deformed rotational model gives a very good fit to the form factors for the positive parity levels with ground-state deformation parameters of $\beta_2 = 0.41$ and $\beta_4 = 0.17$. The form factors for excitation of the 3 and 2^+ states in ^{40}Ca are analyzed by phase-shift analysis, and transition strengths and transition radii are also obtained for these levels. (auth)

16880 STUDY OF EXCITED STATES OF ^{14}O BY A PARTICLE-PARTICLE ANGULAR-CORRELATION TECHNIQUE. Pronko, J. G. (Lockheed Palo Alto Research Laboratory Palo Alto, California 94304); Hirko, R. G.; Slater, D. C. Phys. Rev. C 7: No. 4, 1382-1389 (Apr 1973).

Excited states of ^{14}O have been investigated with the $^{12}C(^3He,n)^{14}O(p)^{13}N$ reaction at an incident-beam energy of 12 MeV. Proton groups corresponding to ^{14}O excited states were observed in time coincidence with the associated neutrons detected at $\theta_n = 0°$. The natural widths of these states (or limits thereof) were obtained directly from the proton spectrum. Angular-correlation data obtained for these proton groups were analyzed according to a general formalism which allows channel spin as well as orbital angular momentum mixing in the ^{14}O–^{13}N+p exit channel. These analyses yield the following spin and width limitations: [E_x (MeV), J, Γ (KeV)]; 5.91, 0 or 1, $\lesssim 47$; 6.29, 2 or 3, 103 ± 6; 6.59, 2, ≤ 56; and 7.78, 1, 2 or 3, 76 ± 10. The apparent dominance of a direct-transfer mechanism for the population of these states permits further spin and parity restrictions. Information regarding the wave-function configurations for these states is discussed on the basis of the observed proton decay. Of particular interest is the observance of an f-wave component in the proton decay of the 6.59-MeV state, which implies an s^4p^8 (p,f) component in the wave function of that state. (auth)

16881 INTERPRETATION OF WEAK AND ELECTROMAGNETIC PROCESSES IN ^{12}C IN THE PARTICLE-HOLE MODEL. Mukhopadhyay, Nimai C. (Center for Theoretical Physics and Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. C 7: No. 4, 1720-1723 (Apr 1973).

Reasons for the success of the particle-hole approach adopted by O'Connell, Donnelly, and Walecka in the unified interpretation of the semileptonic weak and electromagnetic processes in the (A=12) nuclear system will be examined. The example of the analysis of $0^+ + 0^+ \rightleftharpoons 1^+ + 1$ transitions in the context of the particle-hole model (PHM) and the intermediate-coupling model (ICM) brings to light two facts: (1) the nuclear matrix elements relevant to the $0^+ + 0^+ \rightleftharpoons 1^+ + 1$ transitions do not scale in a unique fashion from the PHM to the ICM; (2) the $0^+ + 0^+ \rightleftharpoons 1^+ + 1$ processes at low momentum transfer are overwhelmingly dominated by the Gamow–Teller matrix element. The dominance of a set of processes by one nuclear transition operator is the key to the success of the one-parameter scaling of the particle-hole amplitudes used by O'Connell, Donnelly, and Walecka. (auth)

16882 CROSS SECTIONS FOR $^{10}Be(d,p)^{11}Be$, $^{10}Be(d,\alpha)$ ^8Li, AND $^{10}Be(p,\gamma_0)$ ^{11}B. Goosman, D. R. (Brookhaven National Laboratory, Upton, New York 11973); Kavanagh, R. W. Phys. Rev. C 7: No. 4, 1717-1717 (Apr 1973).

A recently published half-life for ^{10}Be which differs from older measurements requires modification of several published cross sections using ^{10}Be targets. (auth)

16883 PION PRODUCTION BY 185-MEV PROTONS. Keating, Michael P.; Wills, John G. (Indiana University, Bloomington, Indiana 47401). Phys. Rev. C 7: No. 4, 1336-1340 (Apr 1973).

We persent distorted-wave Born-approximation calculations of the reaction $^{12}C(p,\pi^+)^{13}C$ at $T_p = 185$ MeV. It is found that the production cross section to specific states in ^{13}C depends very sensitively on the pion-nucleus distorted-wave function. (auth)

16884 NEUTRONS FROM DEUTERON BOMBARDMENT OF LIGHT NUCLEI. Weaver, K. A. Madison, WI; Univ. of Wisconsin (1972)). 116p. University Microfilms Order No. 73-9230.

Thesis (Ph. D.).

Energy spectra of neutrons from deuteron bombardment of thick Be, Li, and C targets were measured at 5 lab angles from 3.5° to 32.3° by neutron time-of-flight techniques. Also measured were spectra of neutrons from deuteron bombardment of thin D_2 and Be targets. Deuteron energies ranged from 3 to 19 MeV. Deuterons lost about 1 MeV in the thin Be targets and about 0.25 MeV in the D_2 target. The spectra were integrated to give absolute neutron yields or cross sections, and average neutron energies. For deuteron energies above 12 MeV, thick Be and Li produced approximately equal numbers of neutrons at 3.5°, while the yield from thick C was about two-thirds as great. For deuteron energies $E_d > 12$ MeV, cross sections for the D(d,np)D reaction were determined. The average energies of neutrons from thick Be, Li, and C targets were 0.38 E_d, 0.38 E_d, and 0.39 E_d, respectively, for E_d greater than 10 MeV. The average energy of neutrons from thin Be targets was about 0.5 E_d for $E_d > 6$ MeV. From thin-target data neutron yields and average energies were calculated for thicker Be and D_2 targets. Dose rates from several neutron sources were compared. (Diss. Abstr. Int., B)

16885 MEASUREMENT OF THE OUTFLOW OF PHOTONEUTRONS AND CALCULATION OF THE CROSS SECTION OF THE $^{17}O(\gamma,n)^{16}O$ REACTION AT LOW ENERGIES. Berzin, A. K.; Gryaznov, A. L.; Meshcheryakov, R. P.; Startsev, A. A.; Khimenkov, Yu. V. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 9, 113-115(1971). (In Russian).

Yields from the reaction $^{17}O(\gamma,n)^{16}O$ were measured from 4 to 8.5 MeV, and the cross section for the reaction was calculated. It exceeded 0.3 mb at the highest energy. Errors in the determination of photoneutron yield were estimated to be 10 to 15%. Application of these data and the photoneutron method to the estimation of the water-to-oil contact position in oil wells was explored. (2 figures) (RWR)

16886 INELASTIC ELECTRON SCATTERING AND THE WEAK COUPLING MODEL FOR ^{16}O AND ^{18}O. Horsfjord, V. (Nordita, Copenhagen). Nucl. Phys., A209: No. 3, 493-519 (30 Jul 1973).

Form factors and related quantities for a number of even parity transitions in ^{16}O are calculated using wave functions from the weak coupling model introduced by Ellis and Engeland. The theoretical results are compared with existing data. However, in the more interesting cases sufficient data are unfortunately still lacking. Form factors for the two lowest monopole transitions in ^{18}O have also been calculated, and it is pointed out that the corresponding experiments would give valuable data that could shed light on the still unsettled problem of how to describe the structures of the two lowest excited 0^+ levels in ^{18}O. (auth)

16887 PROTON–NEUTRON ANGULAR CORRELATION IN THE REACTIONS $^{12}C(d,pn)^{12}C$ AND $^{13}C(p,pn)^{12}C$. Valley, J. F. Diss. No. 4684. Zurich; Eidgenoessische Technische Hochschule (1971). 43p. (In French).

Thesis.

A method consisting in the case of a sequential-type reaction of the determination, by the skew of the angular correlation, of the mechanism of the first step was applied to the reactions $^{12}C(d,pn)^{12}C$ and $^{13}C(p,pn)^{12}C$. The results confirm the hypothesis of stripping in the $^{12}C(d,pn)^{12}C$ reaction. They made it possible to detect a weak contribution of compound nucleus reactions. The PWBA analysis showed, by its incapacity to take into consideration angular distributions, the importance of the interaction in the initial state. Although the stripping is a surface reaction, this reaction is not purely a Coulomb one as the failure of the MSD model shows. A DWBA approach confirms this. The results obtained during the measurement of the reaction $^{13}C(p,pn)^{12}C$ indicate the importance of the knock-out mechanism. If the angular correlation does not permit the determination of the reaction mechanism as directly as assumed, it is very sensitive and should permit, better than a simple distribution, the verification of the validity of nuclear models for the treatment of the interaction in the initial state. (tr-auth)

16888 CONTINUOUS ^3He SPECTRUM FROM DEUTERONS INCIDENT ON ^{12}C. Strobel, G. L.; Geramb, H. V. (Kernforschungsanlage, Juelich, Ger.). Nucl. Phys.; A210: No. 1, 67-69 (1973).

The $^{12}C(d,^3He)^{11}B^*$ continuous excitation spectrum resulting in a highly excited residual nucleus is explained by a direct reaction mechanism of the deuteron interacting with a correlated pair of nucleons in the target nucleus. Two mechanisms are considered. Either a proton from the correlated nucleon pair is picked up to form the final ^3He and the other nucleon is knocked out of the target nucleus, or deuteron break-up is followed by two-nucleon pick-up. The threshold and shape of the calculated continuous ^3He spectrum agree well with the experimental data. (auth)

16889 MICROSCOPIC DESCRIPTION OF NUCLEAR π^+ PRODUCTION IN ^{12}C. Dillig, M.; Hofmann, H. M.; Huber, M. G. (Univ., Erlangen, Ger). Phys. Lett.; 44B: No. 6, 484-486(11 Jun 1973).

The cross section for the process (p,π^+) is calculated in the framework of the Jastrow model. It is shown that, in contrast to the pure independent-particle model, the experimental data for ^{12}C at $E_p = 185$ MeV can be reproduced quantitatively. (auth)

16890 ALPHA-CLUSTER WAVE FUNCTIONS FOR ^9Be FROM THE $^9Be(p,p\alpha)^5He$ REACTION BETWEEN 35 AND 160 MeV. Hoff-

man, H. J.; Epstein, M. B. (California State Univ., Los Angeles). Nucl. Phys.; A210: No. 1, 126-132(1973).

Harmonic-oscillator, Hulthén, square-well and Woods–Saxon wave functions were used in an attempt to describe the ^{9}Be(p, pα)^{5}He reaction in the context of the plane-wave impulse approximation (PWIA) with radial cut-off. Reasonable fits were obtained to all the data between 35 and 160 MeV by using the Woods–Saxon wave functions, and increasing the cut-off radius for decreasing energy. A consistent value for the effective number of α clusters in ^{9}Be was obtained and found to be 0.2. (auth)

16891 ^{16}O(p,α_0)^{13}N CROSS-SECTION MEASUREMENTS. Nero, A. V.; Howard, A. J. (California Inst. of Tech., Pasadena). Nucl. Phys.; A210: No. 1, 60-66(1973).

Total cross sections for the ^{16}O(p,α_0)^{13}N reaction were measured by observation of the positron decay of the residual ^{13}N nuclei. These cross sections, covering the cm energy range $5.4 \leq E \leq 9.9$ MeV, allow determination of reaction rates of astrophysical interest at temperatures in the neighborhood of 4×10^{9} °K. (auth)

16892 STUDY OF THE ^{12}C(h,p)^{14}N REACTION MECHANISM BY A SYSTEMATIC USE OF THE p–γ ANGULAR-CORRELATION METHOD. Heusch, B.; Gallmann, A. (Centre de Recherches Nucléaires et Université Louis Pasteur Laboratoire de Physique Nucléaire et d'Instrumentation Nucléaire Strasbourg, France). Phys. Rev. C 7: No. 5, 1810-1819 (May 1973).

The mechanism of the reaction ^{12}C(h,p)^{14}N has been studied by measuring the alignment of the 10 bound states of ^{14}N, at 32 incident energies in the range $3 \leq E_h \leq 11$ MeV. These alignments were measured by the angular-correlation technique, using a collinear geometry with detection of the outgoing protons at 0° as well as at 180°. The theoretical alignments which have been calculated both by the direct-interaction model and by the compound-nucleus statistical model, and which are quite different in these two models for levels of natural parity, are almost constant with energy. However, experimentally, strong fluctuations of the alignment have been observed. For the incident energies used in this work, where the mechanism is usually considered intermediate between these two extreme models, it seems that the reaction ^{12}C(h,p)^{14}N proceeds predominantly by the compound nucleus ^{15}O. The giant-resonance structure, or the predominant [p ⊗ ^{14}N] configuration of this nucleus, at the high excitation energies reached in this reaction, can explain theoretically the measured alignments. (auth)

16893 ^{12}C(^{3}He,p)^{14}N REACTION FROM 7 TO 17 MeV. Sokol, J. P.; Prior, R. M.; Rollefson, A. A.; Browne, C. P. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 7: No. 5, 2154-2158 (May 1973).

Yield curves of the ^{12}C(^{3}He,p)^{14}N reaction were taken at 11 angles from 30 to 169° in the beam energy interval of 7 to 17 MeV. From these data, angular distributions and the total cross section were deduced at 0.2-MeV intervals for 7 to 11 MeV and at four higher energies. The results are compared with recent measurements of the same reaction leading to the first nine excited states of ^{14}N. Compound-nuclear effects appear to dominate. There is little correlation between excitation functions for the different states. In contradiction to previous suggestions, little evidence is seen for direct processes. (auth)

16894 THREE-BOSON MODEL OF ^{12}C: A GENERATOR COORDINATE APPROACH. Ananthanarayanan, K.; Best, M.; Gupta, S. Das (Physics Department, McGill University, Montreal, Canada). Phys. Rev. C 7: No. 5, 1760-1766 (May 1973).

The Ali-Bodmer $\alpha\alpha$ potential is used to calculate the properties of the 3α system. A generator-coordinate method is used to solve the three-body problem. Results are compared with the known properties of ^{12}C. (auth)

16895 APPARENT REACTION DEPENDENCE OF THE WIDTH OF THE FIRST EXCITED STATE OF ^{13}N. Clarkson, R. G. (Department of Physics, University of Oregon, Eugene, Oregon 97403). Phys. Rev. C 7: No. 5, 1770-1776 (May 1973).

The width of the first excited state of ^{13}N has been determined from the ^{12}C(d,n)^{13}N* reaction to be $\Gamma = 36.15 \pm 0.54$ keV. This result is compared with those of previous determinations from ^{12}C(p,γ)^{13}N and ^{12}C(p,p)^{12}C experiments. These previous measurements are reviewed and it is shown that they imply a width of $\Gamma = 32.5 \pm 0.55$ keV. This discrepancy is discussed and some possible sources of the differences are examined. (auth)

16896 THRESHOLD PHOTODISINTEGRATION OF ^{6}Li. Shakin, C. M.; Weiss, M. S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). Phys. Rev. C 7: No. 5, 1820-1823 (May 1973).

The low-energy total cross section for the photodisintegration of ^{6}Li is discussed in a sequential-decay model. Satisfactory agreement between theory and experiment is obtained from threshold to γ-ray energies of about 12 MeV in an essentially parameter-free model. (auth)

16897 STATES IN ^{13}C VIA NEUTRON POLARIZATION INVESTIGATIONS FOR THE ^{9}Be(α,n)^{12}C REACTION. De Martini, D. C.; Soltesz, C. R.; Donoghue, T. R. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. C 7: No. 5, 1824-1837 (May 1973).

Angular distributions of the neutron polarization for the ^{9}Be(α,n$_0$)^{12}C and ^{9}Be(α,n$_1$)^{12}C* (4.43-MeV) reactions have been measured at six projectile energies in the 4.5- to 5.85-MeV interval. Large polarizations are observed for both neutron groups over the whole energy range, making both groups useful sources of polarized neutrons. The ground-state neutron-polarization angular distributions have been analyzed simultaneously with the recent cross-section data of Obst et al. using an S-matrix search code to make J^{π} assignments to states in ^{13}C in the 13- to 15-MeV excitation energy range. The combined data set can be adequately described over the whole energy range by assuming the presence of at least five broad states. The J^{π} assignments and the probable excitation energies for these states are given. (auth)

16898 ELASTIC SCATTERING OF α PARTICLES BY ^{9}Be AND HIGHLY EXCITED STATES OF ^{13}C. Goss, J. D.; Blatt, S. L.; Parsignault, D. R.; Porterfield, C. D.; Riffle, F. L. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). Phys. Rev. C 7: No. 5, 1837-1845 (May 1973).

The elastic scattering of α particles by ^{9}Be has been studied in the bombarding energy range of 1.7–6.2 MeV. 10 excitation functions in 50-keV steps and five angular distributions near 5 MeV were measured. The elastic scattering data in the 3.5–5.0-MeV region were analyzed with the compound-nucleus theory using a computer code which evaluates the cross section in the "single-level" approximation. Analysis in terms of seven resonances reproduces many of the features of the data. Tentative spin and parity assignments are given. (auth)

16899 NEUTRON CAPTURE IN FLUORINE BELOW 1500 keV. Macklin, R. L.; Winters, R. R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 5, 1766-1769 (May 1973).

Neutron time-of-flight radiative capture data taken at the Oak Ridge electron linear accelerator have been analyzed for single-level resonance parameters. Eleven resonances were found, with parameters as indicated, listing E_0 (keV), J value assumed, and Γ_γ (eV) in order. 27.07 (2) 1.4 ± 0.3, 48.7 (1) 1.7 ± 0.4, 97.0 (1) $\leq 6.0 \pm 1.8$, 269 (2) 3.5 ± 0.8, 270 (1) ≤ 4.4, 386 (1) $\geq 7 \pm 2$, 490.5 (0) $\geq 10 \pm 3$, 595 (2) $\geq 7 \pm 2$, 1460 (1) $\geq 11 \pm 3$. Values of total width were also found for these resonances. Two resonances are very narrow and their capture areas yield estimates of $g\Gamma_n$. At 43.5 keV, $g\Gamma_n = 0.086 \pm 0.02$ eV if $J \geq 1$ or $\Gamma_n = 0.42 \pm 0.1$ eV if J=0, and, at 173.5 keV, $g\Gamma_n = 0.35 \pm 0.10$ eV. The increase of nearly an order of magnitude in radiative width with increasing energy up to 600 keV is notable. Twelve large resonances between 1600 and 5000 keV were not analyzed for capture because of detector sensitivity to the inelastic scattering channels which open in that energy region. (auth)

16900 SCATTERING OF NEUTRONS BY CARBON FROM 7 TO 9 MeV. Velkley, D. E.; Brandenberger, J. D.; Glasgow, D. W.; McEllistrem, M. T.; Manthuruthil, J. C.; (and others) (Aerospace Research Laboratories, Wright-Patterson Air Force Base, Ohio 45433). Phys. Rev. C 7: No. 5, 1736-1742 (May 1973).

Differential elastic cross sections for neutrons scattered by carbon were measured for 7.20-, 7.35-, 7.73-, 8.20-, and 9.00-MeV incident neutron energies using the Aerospace Research Laboratory neutron time-of-flight facility. The inelastic differential cross sections for neutrons leaving the residual ^{12}C nucleus in the 4.43-MeV excited state were also measured for 7.73-, 8.20-, and 9.00-MeV incident neutrons. These data have uncertainties relative to the normalizations of 1.5 to 8% for the elastic cross sections and 4 to 18% for the inelastic cross sections. The normalization uncertainty is 4%. The elastic angular distributions are compared to optical-model calculations using the Rosen potential. Neither this potential nor any other with reasonable geometry fits the data. The angle-integrated cross sections combined with previously reported ^{12}C(n,α)^{9}Be cross sections are compared to the total neutron cross sections at 7.73, 8.20, and 9.00 MeV. Because of the several strongly overlapping resonances in the 7–9-MeV energy region, a unique phase-shift analysis of the data is not possible. (auth)

16901 EFFECT OF WOODS-SAXON WAVE FUNCTIONS ON CROSS SECTIONS FOR CHARGED-PION PHOTOPRODUCTION FROM ^{16}O. Rao, K. Srinivasa (MATSCIENCE, The Institute of Mathematical Sciences, Madras 600020, India). Phys. Rev. C 7: No. 5, 1785-1791 (May 1973).

The cross sections for charged-pion photoproduction from ^{16}O(0^+, g.s.) leading to the four low-lying bound states $J^{\pi} = 2^-, 0^-, 3^-, 1^-$; T=1 in ^{16}N are calculated in the Woods-Saxon basis. Two-particle-two-hole correlations in the ground-state wave function of ^{16}O are taken into account. Calculations in the Woods-Saxon basis yield more realistic results for the cross sections near the first pion-nucleon resonance region, where high momentum transfers occur, than those obtained in the conventional harmonic-oscillator basis. (auth)

16902 POSSIBLE DIFFERENCE BETWEEN THE MUON- AND ELECTRON-NUCLEAR INTERACTIONS. Barshay, Saul (The Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark). Phys. Rev. D 7: No. 9, 2635-2636 (1 May 1973).

The possible existence of an order α^2, scalar, mass-dependent, lepton–hadron interaction is noted in connection with the recently investigated possible discrepancies in a number of 2p–1s transition energies in muonic atoms. Some relevant further experiments are suggested for the Los Alamos Meson Physics Facility. (auth)

16903 NEW LIMITS ON THE DIFFERENCE BETWEEN THE MUON- AND ELECTRON-NUCLEAR INTERACTIONS. Rinker, George A. Jr. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544); Wilets, L. Phys. Rev. D 7: No. 9, 2629-2634 (1 May 1973).

Muonic-atom and electron-nucleus scattering measurements of nuclear radii have been examined in light nuclei in order to test their relative consistency. The electron data were selected to provide information at the "equivalent momentum transfer," which is approximately 0.3 fm^{-1}. All corrections known to us were applied or considered. Scattering experiments normalized to the Darmstadt ^{12}C cross-section work are found to exhibit a systematic difference from the muon results. When these experiments are renormalized to the recent Amsterdam ^{12}C work, the discrepancy disappears. In the latter case, no muon/electron measurements disagree by more than 0.02 fm. We estimate the standard deviation to be 0.014 fm about a mean of –0.002 fm. The possibility of anomalous lepton–nucleon interactions is discussed. The limits found here still admit observable anomalous effects in, for example, muonic H and He Lamb shifts and muon–nucleon scattering experiments. (auth)

16904 PION-OXYGEN ELASTIC SCATTERING IN THE 3-3 RESONANCE REGION. Phatak, S. C.; Tabakin, F. (Department of Physics, University of Pittsburgh, Pittsburgh, Pennsylvania 15213); Landau, R. H. Phys. Rev. C 7: No. 5, 1803-1809 (May 1973).

The total and differential cross sections for π^-–^{16}O elastic scattering in the 3–3 resonance region are calculated using the first-order optical potential derived from the multiple-scattering theory of Kerman, McManus, and Thaler. In order to include the 3–3 resonance and generate a resonable off-shell behavior of the π–nucleon transition matrix, a separable model is used to construct the π–nucleon transition matrix. The optical potential also includes a proper transformation of the π–nucleon transition matrix from the π–nucleon to the π–nucleus c.m. frames. The results are compared with recent π^-–^{16}O elastic-scattering data and with earlier π^-–^{12}C calculations. (auth)

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Refer also to abstracts 16846, 16865, 16875, 16899, 16942, 16970, 16999, and 17008.

16905 (BMFT-FBK-73-2, pp 29-33) COMPOUND-NUCLEUS REACTIONS IN THE BOMBARDING OF ^{27}Al WITH ^{16}O. Lieb, K. P.; Kleinfeld, A.; Wilke, V. Mar 1973. (In German).

16906 (BMFT-FBK-73-2, pp 40-42) POLARIZATION EXPERIMENTS ON Si AND WITH Si POLARIMETERS. Bangert, R.; Gonsior, B.; Roesner, P.; Roth, M.; Steinmetz, B.; Stroemich, A. Mar 1973. (In German).

16907 (LBL-1690) SYSTEMATICS OF THE $(\alpha,2\alpha)$ REACTION AT E_α = 90 MeV. Sherman, J. D. (California Univ., Berkeley. Lawrence Berkeley Lab). May 1973. Contract W-7405-eng-48. 142p. Dep. NTIS $9.25.

Thesis.

A coincidence technique was used to study the $(\alpha,2\alpha)$ reaction on a series of nuclei at E_α = 90 MeV. Typically, resolutions of 250 to 300 keV fwhm were achieved for the kinematic bands lying in the $T_3 + T_4$ vs. T_3 kinetic energy plane. Nine targets from ^{12}C to ^{66}Zn were studied. The most extensive experimental data were taken on the ^{12}C and ^{16}O targets in order to define the angular correlation shape so that a three-body reaction theory could be more thoroughly tested. The $^{12}C(\alpha,2\alpha)^8Be$ and $^{16}O(\alpha,2\alpha)^{12}C$ reactions included symmetric angle measurements from 19° to 47° in approximate 4° steps; also, an asymmetric angular correlation with one counter fixed at 42° and the other counter ranging from 25° to 47° in 3° steps was taken. Since data were obtained in the energy plane, energy and momentum correlations were also extracted. The seven remaining targets studied by the $(\alpha,2\alpha)$ reaction were ^{24}Mg, ^{26}Mg, ^{28}Si, ^{30}Si, ^{40}Ca, ^{44}Ca, and ^{66}Zn. Symmetric angular correlations were taken in the 28° to 47° range for these nuclei; typically, four angular settings were used for each target. In all cases data were taken at the symmetric quasi-elastic angle. A prominent systematic feature to emerge from this study was the predominance of the ground-state transitions. The ^{40}Ca $(\alpha,2\alpha)$ ^{36}Ar reaction was the only nucleus to yield excited state cross sections that were comparable to the ground-state transition. Another systematic item was that, after a rapid fall of cross section from the p-shell nuclei to the sd-shell nuclei, the $(\alpha, 2\alpha)$ cross sections were found to be nearly constant from the Si isotopes to ^{66}Zn. The angular correlations for transitions to the ground states of these nuclei are very similar. A distorted-wave impulse-approximation (DWIA) calculation was developed; the distortions were described by McCarthy–Pursey wave functions with the focus term set equal to zero. The DWIA was found to fit the angular correlations in shape and magnitude. Systematic features of the energy correlations were also described quite well, although the momentum correlations were fitted in shape and magnitude only for $q \leq 0.5$ $(fm)^{-1}$. The model was used to extract relative spectroscopic factors from ^{12}C to ^{66}Zn, and these results were in good agreement with spectroscopic factors obtained from a DWBA analysis of a systematic (^3He, ^7Be) study. The $^{16}O(\alpha,2\alpha)$ ^{12}C reaction was found to populate the ^{12}C ground state most strongly, whereas the (d, ^6Li) and (^3He, ^7Be) reactions have preferentially populated the $^{12}C(4.44)$ level. Also, theoretical calculations have shown that the $\{^{12}C(4.44) + \alpha\}$ configuration is the principal parent of the ^{16}O nucleus in an alpha-cluster model. Analysis within the plane-wave impulse approximation (PWLA) of the $^{16}O(\alpha,2\alpha)$ ^{12}C reaction still indicated that the $^{12}C(0.0)$ was receiving most of the $(\alpha,2\alpha)$ transition strength. This result indicates that the $(\alpha,2\alpha)$ and alpha pickup reactions are probing four-particle correlations in different manners, and a careful theoretical analysis of the $(\alpha,2\alpha)$ reaction mechanism would be very valuable to nuclear structure studies if these differences were elucidated. (62 figures, 14 tables, 120 references) (auth)

16908 (RLO-1388-214) RECOIL IN (^{16}O, ^{15}N) REACTIONS ON 2s–1d AND 1f–2p SHELL NUCLEI. DeVries, R. M. (Washington Univ., Seattle. Dept. of Physics). 1973. 7p. Dep. NTIS $3.00.

The recently published data and nonrecoil DWBA calculations of Maher, et al., [Phys. Rev., C; 7: 651(1973)] are compared with exact recoil DWBA predictions to study quantitatively recoil effects on single-nucleon-transfer heavy-ion reactions on medium-mass targets at energies ~10 MeV above the Coulomb barrier. (2 figures) (auth)

16909 HIGH SPIN NEGATIVE PARITY STATES IN ^{20}Ne. Zurmuehle, R. W.; Balamuth, D. P.; Fifield, L. K.; Noe, J. W. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 44B: No. 5, 453-455(28 May 1973).

Unambiguous spin and parity assignment were made from angular correlation measurements to states in ^{20}Ne at 15.18 MeV (6^+) and 17.40 MeV (9^-). The results are in disagreement with an earlier 9^- assignment to the 15.18 MeV state. The 17.40 MeV state is assigned to the $K = 2^-$ rotational band based on the 2^- state at 4.97 MeV. (auth)

16910 NUCLEAR DEFORMATION OF ^{28}Si FROM $^{16}O + ^{28}Si$ AND $^{18}O + ^{28}Si$ ELASTIC AND INELASTIC SCATTERING. Gale, D. S. II. Manhattan, KS; Kansas State Univ. (1972). 142p. University Microfilms Order No. 73-13,343.

Thesis (Ph. D.).

Differential scattering cross sections for the elastic and first-excited-state inelastic scattering of ^{16}O and ^{18}O from ^{28}Si were measured at ^{16}O laboratory bombarding energies of 33, 36, and 38 MeV and at an ^{18}O bombarding energy of 36 MeV. The results were analyzed in terms of coupled channels on the basis of a rotational model. For ^{16}O projectiles the deformation of ^{28}Si was found to be $\beta_2 = -0.30 \pm 0.08$ and $\beta_4 \geq +0.1$. The cross sections for the scattering of ^{18}O by ^{28}Si could not be described with the deformation parameters obtained from the $^{16}O + ^{28}Si$ scattering data. The results are compared with recent experiments using different projectiles and with the results of recent theoretical calculations. (Diss. Abstr. Int., B)

16911 STUDY OF ^{26}Al WITH CHARGED PARTICLE INDUCED TRANSFER REACTIONS. Betts, R. R. Philadelphia; Univ. of Pennsylvania (1972). 154p. University Microfilms Order No. 73-13,377.

Thesis (Ph. D.).

The nuclear structure of ^{26}Al was studied using the $^{25}Mg(^3He,d)$, $^{27}Al(^3He,\alpha)$ and $^{24}Mg(^3He,p)$ reactions at a bombarding energy of 18 MeV and the $^{24}Mg(^6Li,\alpha)$ reaction at a bombarding energy of 24 MeV. The beams were produced by the University of Pennsylvania Model EN Tandem Van de Graaff Accelerator, and the reaction products were momentum analyzed in a multiangle magnetic spectrograph. A distorted-wave analysis of the ^3He-induced reactions was performed, and the results were compared with the predictions of various nuclear models. New spin assignments were

made for several levels, and T = 1 character was suggested for some of these. (Diss. Abstr. Int., B)

16912 NEUTRON ASYMMETRIES AND ENERGY SPECTRA FROM MUON CAPTURE IN Si, S, AND Ca. Sundelin, R. M.; Edelstein, R. M. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). Phys. Rev. C 7: No. 3, 1037-1060 (Mar 1973).

The energy dependence of the neutron asymmetry parameter for nuclear capture of muons has been measured in Si, S, and Ca for neutron energies of 4–53 MeV. Contrary to most recent experiments, the asymmetry parameter is strongly positive over much of the energy range, with values as much as 9 standard deviations from zero. Because of the unusual nature of these results the experiment was performed twice and with excellent agreement between the two sets of data. The integrated asymmetry parameter for $E_n > 15.6$ MeV is $+0.316 \pm 0.023$ for Si and $+0.290 \pm 0.034$ for Ca, values which are in direct conflict with the "Standard" V-A theory. Recent theoretical calculations by Bogan and by Piketty and Procureur obtain positive asymmetries, though not yet in good quantitative agreement with these data. The neutron energy spectra from the three targets are all quite similar. They are consistent with a simple exponential falloff in E_n with a decay constant of 7 MeV. The theoretical calculations cited above are in good agreement with higher-energy regions of the spectra. (auth)

16913 DOPPLER-SHIFT ATTENUATION MEASUREMENTS OF LIFETIMES FOR (2s,1d)-SHELL NUCLEI EXCITED BY HEAVY-ION BOMBARDMENT OF ^{2}H. Warburton, E. K.; Olness, J. W.; Engelbertink, G. A. P.; Alexander, T. K. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 7: No. 3, 1120-1132 (Mar 1973).

The Doppler-shift attenuation method was used to measure the lifetimes of nuclear levels formed in the heavy-ion bombardment of titanium deuteride targets. The nuclei formed are those resulting from the "inverse" (d,p) and (d,n) reactions, using beams of ^{18}O, ^{19}F, ^{32}S, ^{34}S, ^{35}Cl, and ^{37}Cl. Target backings of Mg, Al, and Cu were used as stopping media for the γ-decaying nuclei. γ rays were observed, mostly at 0° to the beam, with a 35-cm^3 Ge(Li) detector. New results include mean lifetimes of 1.8 ± 0.34 psec for the ^{33}Cl 811-keV level, 3.3 ± 0.5 psec for the ^{35}S 1574-keV level, and 1.50 ± 0.18 psec for the 2468-keV level of ^{36}Cl. The advantages and limitations of the method are discussed. (auth)

16914 SCATTERING OF 9.8-MeV NEUTRONS FROM SILICON AND SULFUR. Obst, A. W.; Weil, J. L. (Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506). Phys. Rev. C 7: No. 3, 1076-1088 (Mar 1973).

Elastic and inelastic differential cross sections for neutron scattering from Si and S have been measured at an incident neutron energy of 9.8 MeV, using the high-energy neutron group from the ^{9}Be(α,n)^{12}C source reaction. Due to the presence of the 4.439-MeV first-excited-state group from the ^{9}Be(α,n)^{12}C* reaction only the scattering from the ground and first excited states in Si and S could be observed. Measurements were made on both elements by the time-of-flight technique in the angular region $20° \leq \theta_{lab} \leq 150°$ with an average neutron energy spread of 600 keV. The measured yields were corrected for flux attenuation, angular resolution, and multiple scattering. The cross sections were fitted by incoherently adding a compound-nuclear contribution to a direct-reaction contribution calculated by the optical-model-plus-distorted-wave-Born-Approximation method and also by the coupled-channel method. Collective-model fits to S using oblate and prolate deformed rotational-model and vibrational-model form factors were all reasonably good. The fits to Si are not so good, possibly for reasons related to the large fluctuations in the neutron total and differential cross sections for Si in this energy region. The values of β obtained from these fits are, for the most part, consistent with those obtained from other measurements. (auth)

16915 MEAN LIFETIMES OF LEVELS IN ^{26}Al. Gould, C. R.; Tilley, D. R. (North Carolina State University, Raleigh, North Carolina 27607 and Triangle Universities Nuclear Laboratory, Durham, North Carolina 27706); Roberson, N. R. Phys. Rev. C 7: No. 3, 1068-1076 (Mar 1973).

The mean lifetimes of levels in ^{26}Al below 4 MeV have been investigated with the Doppler-shift attenuation method and the ^{24}Mg(^{3}He,p)^{26}Al reaction at 6 MeV. The outgoing protons have been detected at angles of $\pm 60°$ with respect to the beam axis, in coincidence with γ rays detected at 90° in an 80-cm^3 Ge(Li) detector. The results for levels below 3 MeV are generally in agreement with earlier lifetime studies. New information is reported for the following levels (energy in keV, lifetime in fsec): 2741 (54 ± 8), 3074 (290 ± 70), 3161 (36 ± 10), 3597 (44 ± 17), 3680 (27 ± 12), 3721(<23), 3750 (43 ± 9), 3754 (27 ± 11), and 3962 (68 ± 14). The 3074-keV level is assigned positive parity on the basis of the present lifetime results. Experimental transition strengths are extracted and discussed in terms of isospin selection rules in electromagnetic transitions. (auth)

16916 COMMENT ON THE EXISTENCE OF ROTATIONAL STRUCTURE IN ^{26}Al. Betts, R. R.; Fortune, H. T. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. C 7: No. 3, 1257-1259 (Mar 1973).

New spin–parity and isospin assignments in ^{26}Al allow additional states to be placed in previously proposed rotational bands. Two new rotational bands are suggested with $K^{\pi} = 0^+$ and $K^{\pi} = 2^+$. (auth)

16917 MASS-25 ISOBARIC MULTIPLETS. Benenson, W.; Kashy, E.; Proctor, I. D. (Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48823). Phys. Rev. C 7: No. 3, 1143-1146 (Mar 1973).

High-precision mass determinations have now been made for all four members of the lowest two T=3/2 states in the A=25 system. The results are used to compute the coefficients of the isobaric-mass-multiplet equation. (auth)

16918 MASS AND β DECAY OF ^{25}Ne, A $T_z = +5/2$ NUCLIDE. Goosman, David R.; Alburger, D. E. (Brookhaven National Laboratory, Upton, New York 11973); Hardy, J. C. Phys. Rev. C 7: No. 3, 1133-1143 (Mar 1973).

The first reported measurement of the delayed γ-ray spectrum following the β decay of ^{25}Ne is presented. ^{25}Ne recoils from the ^{9}Be(^{18}O,2p)^{25}Ne reaction were thermalized in He gas and transferred through traps to a remotely-located counting station. γ and β rays were counted simultaneously with Ge(Li) and NE102 detectors, respectively. γ-ray energies (in keV) and relative intensities for the ^{25}Na daughter transitions are 89.53 ± 0.10 (95.5 ± 0.6), 979.77 ± 0.16 (18.1 ± 1.9), 1069.30 ± 0.19 (2.34 ± 0.38), 2112.5 ± 1.0 (0.62 ± 0.19), 2202.0 ± 1.0 (1.1 ± 0.3), and 3688 ± 3 (0.96 ± 0.24). The ground-state β branch has been measured to be less than 20% of all β branches. The ^{25}Na excitation energies (in keV) and β branches (in %, assuming the ground-state branch is zero) are 89.53 ± 0.10 (76.8 ± 1.9), 1069.32 ± 0.19 (19.2 ± 2.0), 2202 ± 1 (2.3 ± 0.5), and 3688 ± 3 (1.18 ± 0.30). A 0.52 ± 0.15% branch is tentatively assigned to a state in ^{25}Na at 4289 ± 3 keV, on the basis of an observed 3220 ± 3-keV γ ray. The half-life of ^{25}Ne has been measured to be 602 ± 8 msec. By measuring the end-point energy of the β spectrum populating the first excited state of ^{25}Na the mass excess of ^{25}Ne has been measured to be -1.96 ± 0.30 MeV. Comparison of the mass and decay of ^{25}Ne with theoretical estimates and models is made. (auth)

16919 LIFETIMES IN ^{33}P BY THE DOPPLER-SHIFT-ATTENUATION METHOD. Poletti, A. R.; Bardin, T. T.; Pronko, J. G.; McDonald, R. E. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). Phys. Rev. C 7: No. 4, 1433-1440 (Apr 1973).

Lifetimes of low-lying states in the nucleus ^{33}P have been measured by the Doppler-shift-attenuation method. Energies (in keV) and lifetimes (in psec) are as follows: 1431.4 (0.70 ± 0.15); 1847.6 (1.40 ± 0.30); 2537.6 ± 1.2 (0.03 ± 0.01); 3274.9 ± 2.0 (0.19 ± 0.04); 3490.8 ± 1.5 (0.09 ± 0.02); 3628.6 ± 1.5 (0.26 ± 0.04); 4047.6 ± 1.3 (0.08 ± 0.04); 4193.5 ± 2.5 (<0.04); 4223.3 ± 2.3 (0.52 ± 0.10); 4856.1 ± 1.2 (<0.11); 5048.7 ± 3.0 (<0.09); 5190.5 ± 3.0 (<0.18); 5405.6 ± 3.2 (<0.11); 5449.3 ± 2.6 (>1.8); 5497.8 ± 2.5 (<0.09); 5548.5 ± 2.8 (0.47 ± 0.17); 5557.8 ± 3.0 (<0.08); 5644.0 ± 4.0 (...); 5674.1 ± 3.0 (<0.07); 5785.1 ± 3.0 (<0.05); 5816.0 ± 2.0 (0.11 ± 0.06); 5969.8 ± 4.0 (<0.08); 6115.3 ± 3.2 (<0.20); 6123.5 ± 5.0 (0.08 ± 0.06); 6181.7 ± 3.5 (<0.09). Combining information on lifetimes, decay modes, and mixing ratios with known spin assignments, allowed the following spin-parity assignments to be made: 3.28-MeV level ($J^{\pi} = 3/2^{\pm}$, $5/2^+$); 3.49 ($5/2^+$); 4.05 ($3/2^+$, $5/2^+$); 4.19 ($5/2^+$); 5.19 ($3/2^+$, $5/2^{\pm}$). For a number of the low-lying levels the results are compared to theory. (auth)

16920 MECHANISM OF THE REACTION ^{28}Si(d,p)^{29}Si FROM 2.0 TO 4.2 MeV. Hsu, C. C.; Pai, T. P. (Department of Physics, National Tsing Hua University, Hsinchu, Taiwan, China); Tohei, T.; Morita, S. Phys. Rev. C 7: No. 4, 1425-1432 (Apr 1973).

Excitation curves and angular distributions for the reaction ^{28}Si(d,p)^{29}Si have been measured over the range of bombarding enregy from 2.0 to 4.2 MeV. The proton groups leading to the five lowest states of ^{29}Si were measured. The results are analyzed by the methods of fluctuation theory and of average angular distribution using the Hauser-Feshbach formula and the distorted-wave Born approximation theory. Ratios of the direct reaction to the compound nucleus cross section obtained from the two methods are compared. The average total level width $\langle \Gamma \rangle = 29$ keV, the average level space of spinless $D_0 = 1.38$ keV, spin cutoff parameter $\sigma^2 = 2.5$, nuclear temperature t=1.8 MeV, and moment of inertia $I = 0.6 \times 10^{-42}$ MeV sec^2 of ^{30}P around 14.78-MeV excitation energy are obtained. (auth)

16921 ^{33}P: ANGULAR CORRELATION STUDIES OF EXCITED STATES. Poletti, A. R.; Bardin, T. T.; McDonald, R. E.; Pronko, J. G. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). Phys. Rev. C 7: No. 4, 1479-1489 (Apr 1973).

The ^{31}P (t,p) ^{33}P reaction has been used to investigate the spins and decay of ^{33}P below an excitation energy of 6.17 MeV, as well as the

multipole mixing ratios of the transitions between these levels. γ radiation was detected simultaneously in five NaI (Tl) detectors located at angles equivalent to 5, 35, 45, 60, and 90°, while outgoing protons were detected in an annular detector placed at 180° with respect to the beam direction. Multiparameter techniques were used to measure the p–γ coincidence spectra. Spin assignments were confirmed for the following levels [E_x (MeV) (J)]:1.43 (3/2), 1.85 (5/2), 2.54(3/2), 3.28(3/2 or 5/2), 3.63(7/2), 4.05(3/2 or 5/2, 4.22(7/2). Assignments were made for these levels: 3.49 (5/2), 4.19(5/2), 4.87(3/2), 5.05(3/2), 5.56(3/2), 5.66(1/2,3/2), 5.73(3/2). (auth)

16922 TEST OF THE INDEPENDENCE POSTULATE IN THE BOHR THEORY OF COMPOUND-NUCLEUS DECAY: ^{50}CR* SYSTEM. Go, Man King; Markowitz, Samuel S. (Department of Chemistry, and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 7: No. 4, 1464-1470 (Apr 1973).

Excitation functions for the production of ^{48}V and ^{48}Cr from incident ions ^{3}He, α, ^{16}O, ^{18}O, and ^{22}Ne involving the compound system ^{50}Cr* have been measured. Test of the independence postulate was performed in a Ghoshal type of experiment. Effects of the nuclear Coulomb barrier and high reaction Q value upon the two-nucleon evaporation excitation functions were noted. For all the reaction pairs, the ^{48}V production is more than a factor of 10 bigger than the corresponding ^{48}Cr cross section. This phenomenon can be explained by the effect of odd–even nucleon number of the product nucleus. Simple calculations of the angular momentum and rotational energy of the compound nucleus were performed. The energy shift of the excitation function can be explained by the effect of angular momentum. The reactions involved were found to be generally consistent with the compound-nucleus model. (auth)

16923 LINEAR-POLARIZATION MEASUREMENTS OF THE GAMMA-RAY TRANSITIONS IN ^{20}F. Hardy, K. A. (Florida International University, Miami, Florida 33144); Lee, Y. K. Phys. Rev. C 7: No. 4, 1441-1445 (Apr 1973).

Linear-polarization and angular-distribution measurements are reported for the γ rays from the decay of the 636-, 823-, 984-, 1057-, 1309-, and 2044-keV levels in ^{20}F. Using our data, in addition to that of previous workers, the levels at 984 and 1309 keV were found to have negative parity, as opposed to the previous assumption of positive parity. Spins and parities of the other levels are discussed, as well as the mixing ratios of the decay γ rays. (auth)

16924 INVESTIGATION OF THE ^{31}P(d,p)^{32}P REACTION AT E_d = 10 MeV. van Gasteren, J. J. M.; Verhage, A. J. L.; van der Veen, J. F. (State Univ., Utrecht). Nucl. Phys.; A210: No. 1, 29-37(1973).

The reaction ^{31}P(d,p)^{32}P was used to investigate the structure of ^{32}P. Angular distributions for 22 levels up to and including an excitation energy of 4.16 MeV were measured with a split-pole magnetic spectrograph at a bombarding energy of 10 MeV. A DWBA analysis yielded l_n values and spectroscopic factors. The results are compared with recent many-particle shell-model calculations. (auth)

16925 SPECTROSCOPY OF ^{32}P. van Eijkern, F. E. H.; van Middelkoop, G.; Timmer, J.; van Luijk, J. A. (State Univ., Utrecht). Nucl. Phys.; A210: No. 1, 38-50(1973).

Particle-gamma angular correlations were measured with the ^{29}Si(α,pγ)^{32}P reaction at bombarding energies E_α = 10.65, 10.69, and 11.00 MeV. Together with DSA lifetime measurements these experiments lead to seven unambiguous spin assignments to levels below 3.5 MeV excitation energy in ^{32}P. In addition, the measured mixing ratios and branching ratios yield many dipole and quadrupole transition strengths. The previously known 3.44 MeV level is a doublet with components at 3,443.0 ± 0.6 and 3,444.0 ± 0.9 keV. (auth)

16926 (p,n) ISOBARIC ANALOG TRANSITIONS IN TARGETS OF ^{27}Al, ^{51}V, AND ^{90}Zr AT 22, 30, AND 40 MeV. Jolly, R. K.; Amos, T. M.; Galonsky, A.; Hinrichs, R.; St. Onge, R. (Cyclotron Laboratory, Physics Department, Michigan State University, East Lansing, Michigan 48823). Phys. Rev. C 7: No. 5, 1903-1913 (May 1973).

Angular distributions for (p,n) transitions to isobaric analog states of ^{27}Al, ^{51}V, and ^{90}Zr targets have been measured at proton energies of 22, 30, and 40 MeV. The data have been compared with results of macroscopic distorted-wave Born-approximation calculations employing various form factors: pure volume, pure surface, and mixtures of real volumes with imaginary surface. The comparisons show that: (i) The surface interaction describes the data rather well, particularly at the lower energies, whereas the volume interaction is adequate only at 40 MeV; (ii) complex mixtures of volume and surface give good descriptions of most of the data if the mixture is a variation of the isospin part of the Becchetti–Greenlees potential with either increased surface-to-volume ratio or increased imaginary radius; (iii) use of the unmodified Becchetti–Greenlees geometry gives a poor fit to much of the data; (iv) the strength of the isospin interaction decreases with increasing energy, in general agreement with other charge-exchange work. Most of the decrease here occurs between 22 and 30 MeV. This is true for the surface interaction and for each of the two complex interactions. (auth)

16927 NUCLEAR DEFORMATION OF ^{28}Si FROM ^{16}O + ^{28}Si ELASTIC AND INELASTIC SCATTERING. Gale, D. S.; Eck, J. S. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). Phys. Rev. C 7: No. 5, 1950-1956 (May 1973).

Differential scattering cross sections for the elastic and first excited state inelastic scattering of ^{16}O and ^{18}O from ^{28}Si have been measured at ^{16}O laboratory bombarding energy of 33, 36, and 38 MeV and at an ^{18}O bombarding energy of 36 MeV. The experimental results have been analyzed in terms of coupled channels on the basis of a rotational model. For ^{16}O projectiles the deformation of ^{28}Si was found by this technique to be $\beta_2 = -0.30 \pm 0.08$ and $\beta_4 \geq +0.1$. The cross sections for the scattering of ^{18}O by ^{28}Si could not be described with the deformation parameters obtained from the ^{16}O + ^{28}Si scattering data. The present results are compared with recent experiments using different projectiles and with the results of recent theoretical calculations. (auth)

16928 ELECTROMAGNETIC TRANSITION RATES IN ^{38}Cl AND ^{40}K. Wedberg, G. H. (Argonne National Laboratory, Argonne, Illinois 60439); Segel, Ralph E. Phys. Rev. C 7: No. 5, 1956-1965 (May 1973).

The attenuated-Doppler-shift method was used to measure the mean lives of low-lying states in ^{38}Cl and ^{40}K. States were populated by the (d,p) reaction and the recoil direction was defined by coincidence with the outgoing proton. While the positions of the levels in these two nuclei give encouragement to the belief that many of the states are well described as members of simple particle–hole or particle–particle multiplets, it is immediately apparent that the magnetic dipole transition rates do not fit the simple picture even if effective moments are used. A recent theoretical study has shown that some admixtures that can be expected will significantly alter the M1 rates, but the present results are not in good agreement with the theoretical predictions. Other available lifetime data on these nuclei support the present contention that there are severe discrepancies between the observed rates and those predicted by the best available shell-model calculations. (auth)

16929 ELECTRIC DIPOLE STRENGTH IN ^{23}Na OBSERVED WITH THE CAPTURE REACTION ^{22}Ne(p,$\gamma_0 + \gamma_1$)^{23}Na. Ventura, E. (Department of Physics, Stanford University, Stanford, California 94305). Phys. Rev. C 7: No. 5, 1900-1903 (May 1973).

The differential cross section for the capture reaction ^{22}Ne(p,$\gamma_0 + \gamma_1$)^{22}Na has been measured. Significant structure is observed in the giant-resonance region. Comparison with the reaction ^{23}Na(γ,n)^{22}Ne indicates a splitting of the dipole strength. Possible sources of this splitting are discussed. (auth)

16930 GAMMA-RAY SPECTROSCOPY OF LOW-LYING LEVELS IN ^{28}Mg. Fisher, T. R.; Bardin, T. T.; Becker, J. A.; Chase, L. F. Jr.; Kohler, D.; (and others) (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). Phys. Rev. C 7: No. 5, 1878-1885 (May 1973).

Excitation energies, spins, and nuclear lifetimes have been measured in ^{28}Mg by employing the reaction ^{26}Mg(t,pγ)^{28}Mg at bombarding energies in the neighborhood of 2.9 MeV. Reaction-produced protons were detected in an annular Si counter at an average angle of 171°, and coincident-γ-ray spectra were obtained with both NaI(Tl) and Ge(Li) detectors at angles $120° \geq \theta \geq 0°$. γ-ray angular distributions were extracted from data obtained with the NaI(Tl) detectors, while precision γ-ray energies and Doppler-shift attenuations were extracted from the data collected with the Ge(Li) detector. The results obtained for excitation energies (KeV), spins, and lifetimes (psec) are: 1473.8 ± 0.4, 2, 1.60 ± 0.20; 3862.9 ± 0.7, 0, 1 or 2, 0.75 ± 0.10; 4021.2 ± 1.6, 4, 0.21 ± 0.07; 4557.4 ± 0.8, 2, <0.04; 4877 ± 4, 2, <0.18; 5171.6 ± 0.8, 3, 0.10 ± 0.07; 5190.7 ± 3.0, 1, <0.03; 5470.5 ± 5, 2, undetermined. γ-ray branching ratios and multipole-mixing ratios were also obtained from the data, and reduced electromagnetic transition matrix elements have been extracted for all transitions observed. The results are compared with the predictions of both the triaxial rotor model of Kurath and the shell-model calculations of de Voigt and Wildenthal. (auth)

16931 STATES OF ^{35}Cl VIA THE ^{32}S(α,p)^{35}Cl REACTION. Goss, J. D.; Stocker, H.; Detorie, N. A.; Browne, C. P.; Rollefson, A. A. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). Phys. Rev. C 7: No. 5, 1871-1877 (May 1973).

Protons from the ^{32}S(α,p)^{35}Cl reaction were analyzed with broad-range magnetic spectrographs. Data were taken at nominal bombarding energies of 20.0 and 20.28 MeV and at observation angles ranging from 15 to 120°. 102 levels have been identified in ^{35}Cl in the region of excitation from the ground state to 10.8 MeV. Uncertainties in excitation energies above 3.2 MeV have been reduced by as much as a factor of 5 from previous work, and 57 previously unreported levels were observed. (auth)

Nuclear Properties and Reactions, $39 \leq A \leq 58$

Refer also to abstracts 15621, 16846, 16865, 16879, 16907, 16908, 16922, 16926, 16928, 16962, 16964, 16980, 16999, 17008, 17088, 17089, 17096, and 17120.

16932 (LYCEN-7304) α EMISSION SPECTRA OF THE ^{58}Co NUCLEUS EXCITED TO 39 MeV IN THE FOLLOWING CHANNELS p + ^{57}Fe, d + ^{56}Fe, and ^{3}He + ^{55}Mn. Pre-Equilibrium α De-Excitation. Hollinger, G. (Lyon Univ. (France). Institut de Physique Nucleaire). Jan 1973. 71p. (In French). Dep. NTIS (U. S. Sales Only) $5.75.

Thesis. Submitted to Lyon Univ. (France).

The α emission spectra of the ^{58}Co nucleus excited to 39 MeV in the channels p + ^{57}Fe, d + ^{56}Fe, and ^{3}He + ^{55}Mn were measured and analyzed. The hybrid Blann formalism (preequilibrium statistical model) was adapted and discussed for the case of α emission. The model is compared with the different spectra obtained for the ^{57}Fe(p,α), ^{56}Fe(d,α), and ^{55}Mn(^{3}He,α) reactions at 39 MeV and the ^{209}Bi(p,α) reaction at 43 MeV. The preformation factor for α excitons was evaluated at 0.1 to 0.2, and corresponds to published values for heavy nuclei. The value adopted for the free path of α particles in nuclear matter is perfectly realistic. A diffuse boundary nuclear model is introduced and a partial-wave hybrid analysis, used to localize the majority of the pre-equilibrium α emission at the surface of the nucleus. In the case of heavy nuclei interpreted in terms of knock-out, partial-wave analysis enabled the geometrical dependence of the preformation factor to be determined as a function of the nuclear matter density. Analysis of the results obtained for the ^{209}Bi(p,α) reaction did not establish whether the surface was totally or partially composed of alpha substructures. In the Fe region, it was possible to determine the relative proportions of the compound and precompound mechanisms taking place. (FR)

16933 STUDY OF THE ^{50}V NUCLEUS WITH THE (^{3}He,d), (^{3}He,α), (^{3}He,p), AND (^{3}He,pγ) REACTIONS. Smith, J. W. (Argonne National Laboratory, Argonne, Illinois 60439); Meyer-Schützmeister, L.; Braid, T. H.; Singh, P. P.; Hardie, G. Phys. Rev. C 7: No. 3, 1099-1119 (Mar 1973).

The nucleus ^{50}V has been studied with the ^{49}Ti(^{3}He,d), ^{51}V(^{3}He,α), ^{48}Ti(^{3}He,p), and ^{48}Ti(^{3}He,pγ) reactions induced by the ^{3}He^{++} beam from the Argonne tandem Van de Graaff. The (^{3}He,d), (^{3}He,α) and (^{3}He,p) angular distributions at E(^{3}He) = 22 MeV and with 20-, 30-, and 75-keV over-all resolution, respectively, have been analyzed with the distorted-wave Born approximation. The (^{3}He,p) and (^{3}He,pγ) reactions were also studied at 13 MeV to obtain the γ decay of ^{50}V levels (including two 0^+ isobaric analog states) in which the neutron-proton pair is transferred with zero orbital angular momentum. The two 0^+ isobaric analog states are observed to decay by M1 transitions to two different low-lying 1^+ states, one of which is $f_{7/2}$ and the other is a complex configuration. Several levels between 1.3 and 4 MeV excitation energy are seen to decay in part to the 1^+ levels populated by decay of the two 0^+ analog states. The ^{50}V levels at 1.333 and 1.490 MeV are assigned 1^+, and the previous tentative spin assignments 5^+, 4^+, 3^+, and 2^+ of the first four excited states are supported. All available data are used to evaluate two models: (1) the truncated $1f_{7/2}$ shell model of McCullen, Bayman, and Zamick and (2) the Coriolis-coupling model of Wasielewski and Malik. (auth)

16934 STUDY OF ^{42}Ar USING THE ^{40}Ar(t,pγ)^{42}Ar REACTION. Pronko, J. G.; McDonald, R. E. (Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304). Phys. Rev. C 7: No. 3, 1061-1068 (Mar 1973).

Nuclear properties of the excited states of ^{42}Ar were measured by using the ^{40}Ar(t,pγ)^{42}Ar reaction at a bombarding energy of 2.9 MeV. Angular correlations of γ rays were measured using a spectrometer consisting of five NaI(Tl) counters in time coincidence with an annular particle detector positioned about 180°. The analysis of these correlations yielded multipole-mixing and branching-ratio information for the electromagnetic deexcitations of ^{42}Ar states, as well as spin assignments for some of the excited states. Coincident γ-ray spectra were also obtained using a Ge(Li) detector. Some of the measured excitations and spin assigment [E_x (keV); J] are: [1207$\pm$1.5; 2], [2414$\pm$5], [2485$\pm$3; 2], [2510$\pm$3], [3012$\pm$3; 1, 2, 3], [3092$\pm$3; 4], [3555$\pm$3; 2], [4004$\pm$5], [4123$\pm$4; $\leq$2], [4285$\pm$5; 1, 2, 3], and [4629$\pm$5; $\geq$1]. The results of this experiment are compared with recent shell-model calculations. (auth)

16935 ELECTRON SCATTERING FROM ^{51}V. Peterson, G. A. (Department of Physics, University of Massachusetts, Amherst, Massachusetts 01002); Hosoyama, K.; Nagao, M.; Nakada, A.; Torizuka, Y. Phys. Rev. C 7: No. 3, 1028-1037 (Mar 1973).

Form factors for the excitation of the ^{51}V 0.32-, 0.93-, 1.61-, 1.81-, and 2.70-MeV members of the $(1f_{7/2})^3$ multiplet, and of the 2.40- and 3.91-MeV states have been measured for momentum transfers up to 1.8 fm^{-1} by using 183- and 250 MeV electrons. Comparisons have been made with form factors calculated by using harmonic-oscillator shell-model wave functions. For the $(1f_{7/2})^3$ multiplet, effective charges from 1.79e to 2.01e were obtained for the E2 components of the excitations, and 1.69e for the E4 comoponent of the 2.70-MeV excitation. Higher multipole components of each excitation required smaller effective charges in the strict $(1f_{7/2})^3$ configuration. An analysis of the elastic scattering data using a Fermi charge distribution yielded the parameters c=3.94$\pm$0.03fm, t=2.22$\pm$0.06fm, and 3.58$\pm$0.04fm for the rms radius. (auth)

16936 SPECTROSCOPY OF ^{52}Mn FROM THE ^{54}Fe(d,α) REACTION AT 15 MeV. Gaillard, P.; Grossiord, J.-Y.; Guichard, A. (Institut de Physique Nucléaire, Université Claude Bernard de Lyon). Phys. Rev. c 7: No. 3, 1147-1153 (Mar 1973).

The ^{54}Fe(d,α)^{52}Mn reaction has been studied at 15 MeV incident energy. Angular distributions, up to an excitation energy of 4.7 MeV, have been obtained. Distorted-wave Born-approximation calculations have been carried out on the basis of the two-nucleon-transfer theory of Glendenning. The results provide information on the configuration of ^{52}Mn levels. (auth)

16937 HARTREE-FOCK-BOGOLIUBOV PROJECTED SPECTRA: Cr AND Fe ISOTOPES. Banerjee, B. (Division de Physique Théorique, Institut de Physique Nucléaire, 91-Orsay, France); Khadkikar, S. B.; Devi, K. R. Sandhya. Phys. Rev. C 7: No. 3, 1010-1016 (Mar 1973).

The intrinsic states of Cr and Fe isotopes are calculated by solving Hartree-Fock-Bogoliubov equations in the 2p-1f shell using a deformed basis and the Rosenfeld-Yukawa potential. The projection of angular momentum states is carried out and the results are compared with the projected Hartree-Fock and experimental spectra. (auth)

16938 SEARCH FOR ALPHA CLUSTERS IN THE A = 40 REGION. Park, D. Y. (Los Angeles; Univ. of Southern California (1973)). 115p. University Microfilms Order No. 73-14,431.

Thesis (Ph. D.).

The ^{40}Ca(p,α)^{37}K, ^{40}Ar(p,α)^{37}Cl, and ^{40}Ca(p,pα)^{36}Ar reactions were studied at 45 MeV incident proton energy. The angular distributions from the (p,α) reactions were obtained at 15° to 120°. They showed strong forward peaking. The data were analyzed with a zero-range DWBA code (JULIE) using a cluster form factor in the pick-up mechanism. The agreement of the calculated cross sections with the experimental distributions was generally very good. A pick-up mechanism was also found to be dominant in (p,^{3}He) reactions on the same nuclei. The (p,^{3}He) cross sections leading to the ground state turned out to be of about the same order of magnitude as those for the (p,α) reactions; the same is true for the (p,^{3}He) data on ^{40}Ca leading to an excited state of ^{38}K. An analysis of all the data with a pick-up DWBA calculation gave very good agreement, indicating that deuteron pick-up is indeed important in these reactions. Finally, the question of alpha clustering was studied in a ^{40}Ca(p,pα) coincidence experiment. Although angles were chosen to emphasize the enhancement in the cross sections due to quasi-elastic scattering, all cross sections were found to be very small so that no enhancement could be positively identified. Again, the results were compatible with the interpretation that alpha clustering is not so important in this region as had been assumed. (RWR)

16939 NEAR-THRESHOLD NEUTRONS FROM (p,n) REACTIONS ON INTERMEDIATE-WEIGHT NUCLEI. Kneff, D. W. (Eugene, OR; Univ. of Oregon (1972)). 124p. University Microfilms Order No. 73-13,743.

Thesis (Ph. D.).

Neutron time-of-flight spectra were accumulated and analyzed for (p,n) reactions on five intermediate-weight nuclei. The time-of-flight spectra were characterized by several well-defined resonance peaks corresponding to highly excited target + proton compound nucleus levels. Q values were deduced for the ^{41}K(p,n)^{41}Ca, ^{45}Sc(p,n)^{48}Ti, ^{51}V(p,n)^{51}Cr, and ^{57}Fe(p,n)^{57}Co ground-state reactions. The ^{41}K(p,n)^{41}Ca result (−1203.8 ± 0.5 keV) disagrees with Q-value determinations from the published threshold measurements, establishing a resonance error in the latter work. The means of extracting peak differential cross sections and Breit−Wigner widths from time-of-flight resonances was developed and applied to the most prominent near-threshold resonances of the reactions ^{45}Sc(p,n)^{45}Ti, ^{51}V(p,n)^{51}Cr, and ^{57}Fe(p,n)^{57}Co. The ^{65}Cu(p,n)^{65}Zn ground state reaction threshold is dominated by a narrow 2^- or 3^- ^{66}Zn resonance 148 eV above the 2.17 MeV reaction threshold. Neutrons from this resonance lie within a forward cone of half angle 33°, and have laboratory energies of 1180.9 ± 4.6 and 107.6 ± 0.6 eV for 0° and 180° C.m. angles, respectively. These energies indicate a velocity decrease of 0.7% for the recoiling compound system before neutron decay. The product

of the peak cross section and resonance width is 570 ± 50 mb-eV, and the width is between 2 and 10 eV. ^{57}Fe(p,n)^{57}Co neutron time-of-flight spectra were measured for proton energies just above the ground-state threshold. They demonstrated that the time-of-flight technique using a thick target can provide a series of high-resolution windows for looking at a compound nucleus in highly excited states. The (p,n) yields through ^{58}Co resonances to the 1.38-, 1.51-, 1.76-, and 1.9-MeV excited states of ^{57}Co are 30 to 100 times larger than the ground state yields. (RWR)

16940 SPECTROSCOPY OF ODD–ODD NUCLEI IN THE $f_{\frac{7}{2}}$-SHELL–^{50}V AND ^{52}Mn. Delvecchio, R. M. (Pittsburgh; Univ. of Pittsburgh (1972)). 101p. University Microfilms Order No. 73-13,200.

Thesis (Ph. D.).

A new DWBA procedure which minimizes uncertainties due to finite-range corrections and optical-parameter ambiguities is presented; it was used to analyze ^{52}Cr(d,α)^{50}V and ^{54}Fe(d,α)^{52}Mn angular distributions obtained at 17 MeV bombarding energy. Because of the (d,α) selection rule which forbids the pickup of a $(l_j)^2_{J=\text{even}}$ pair, the J = even levels of the $f_{\frac{7}{2}}$ configuration should be excited only to the extent that configuration mixing is present. (d,α) L-transfer values were extracted for 30 levels in ^{50}V and 28 levels in ^{52}Mn. Energies for about 50 levels up to 3 MeV of excitation in ^{50}V are presented, along with spin–parity limits based on this and previous work for many of these levels. A ^{52}Cr(p,nγ)^{52}Mn coincidence experiment was performed to supplement the (d,α) work. Thirty γ rays could be fitted into a decay scheme which included four previously unreported levels at low (<1.3 MeV) excitation. Since the γ rays were observed with 3 keV Ge(Li) detector resolution, accurate energy assignments (≤ ±0.5 keV) could be made for 14 levels in ^{52}Mn. Altogether, 20 levels participated in the decay scheme up to and including the analog state at 2925 keV. The particle data permitted energy assignments to some 60 levels in ^{52}Mn up to about 4 MeV of excitation with accuracies ranging from ±1 to ±10 keV. The γ-ray data are consistent with the (d,α) spin limits in ^{52}Mn. A comparison of the low-lying, presumably $(f_{\frac{7}{2}})^4$ configuration, states in both nuclei with the calculations of McCullen, Bayman, and Zamick is presented. (RWR)

16941 LIFETIMES OF NEGATIVE-PARITY STATES OF ^{49}Sc BY THE ^{48}Ca(p,γ)^{49}Sc REACTION. Struve, Horton; Thomas, H. C. (Department of Physics, Texas Tech University, Lubbock, Texas 79409); Bennett, Michael J.; Armstrong, Dale D. Phys. Rev. C 7: No. 4, 1418-1424 (Apr 1973).

The mean lifetimes for 18 γ-ray transitions in ^{49}Sc were determined using the Doppler-shift-attenuation method. Previously unreported γ rays of 1620, 4275 and 6010 keV were observed and placed in a decay scheme. Evidence is presented indicating that the correct spin assignment for the 4493-keV state is (1/2) rather than (3/2). The low-lying negative-parity states of ^{49}Sc are calculated using a simple model in which a single proton in the 2p1f shell is coupled to positive-parity core states in ^{48}Ca. The model reproduces most of the single-particle levels quite well. Fair agreement is obtained between calculated and experimentally determined E2 and M1 transition rates except for the (5/2) to (7/2) transitions. (auth)

16942 RECOIL-DISTANCE LIFETIME MEASUREMENTS IN ^{46}Ti AND ^{50}Cr. Dehnhardt, W.; Kistner, O. C.; Kutschera, W.; Sann H. J. (Max-Planck-Institut für Kernphysik, Heidelberg). Phys. Rev. C 7: No. 4, 1471-1478 (Apr 1973).

The mean lifetimes of several excited states in the cross-conjugated nuclei ^{46}Ti and ^{50}Cr were measured with the recoil-distance Doppler-shift method. The levels were fed via the ^{32}S(^{16}O,2p) and ^{40}Ca(^{12}C,2p) reactions, respectively, which lead to a strong population of high-spin levels in the residual nuclei. Lifetimes of the ground-state bands up to the 6^+ states were measured in both nuclei. A decrease of the B_l (E2) values with increasing spin was found. (auth)

16943 HALF-LIVES OF ^{46}V, ^{50}Mn, AND ^{54}Co. Alburger, David E. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 7: No. 4, 1440-1441 (Apr 1973).

The nuclides ^{46}V, ^{50}Mn, and ^{54}Co were formed via the (p,n) reaction at $E_p = 10$ MeV and half-lives were measured by observing β rays in a plastic scintillator. Values obtained were 425.3 ± 2.0, 285.1 ± 0.9, and 193.1 ± 0.8 msec, respectively. The results agree with previous work within errors and thus confirm the systematic behavior of these 0^+–0^+ superallowed Fermi β decays. (auth)

16944 STATIC QUADRUPOLE MOMENT OF THE GROUND STATE OF ^{53}Cr DETERMINED BY COULOMB EXCITATION. Thomson, J. A.; Scharenberg, R. P.; Lutz, W. R.; Larsen, R. D. (Tandem Accelerator Laboratory, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 7: No. 4, 1413-1418 (Apr 1973).

In order to compare the reorientation-effect technique with traditional measurements the static quadrupole moment of the 3/2⁻ ground state of ^{53}Cr has been determined. Thin foils (100–150 μ/cm²) of enriched ^{53}Cr were bombarded by 55- and 59-MeV ^{32}S projectiles from the Purdue University tandem accelerator. The relative excitation probability of the 0.54-MeV spin 1/2⁻ first excited state was measured as a function of projectile scattering angle with a particle-γ-ray coincidence technique. From these data and with the aid of the Winther-de Boer multiple-coulomb-excitation program the static quadrupole moment of the 3/2⁻ ground state was determined to be $Q = +0.04 \pm 0.07$ b. Contributions to the excitation probability of the 1/2⁻ state via the 5/2⁻ second excited state are assumed to be negligible. This value of Q is in agreement with the value $|Q| = 0.026$ b determined from NMR data by Artman. This agreement strongly suggests that the reorientation effect is the dominant higher-order process which appreciably contributes to the excitation probability of the first excited state of ^{53}Cr. (auth)

16945 (d,α) REACTION IN ^{56}Fe AT 12 MeV. Majumder, A. R. (Univ. of Dacca, Bangladesh); Gupta, H. M. S.; Guichard, A. Nucl. Phys.; A209: No. 3, 615-628(30 Jul 1973).

The (d,α) reaction in ^{56}Fe is studied at $E_d = 12$ MeV, and angular distributions of the α-particles are obtained over the angular range 13° to 83° (cms); the results are analyzed in terms of the DWBA theory of direct reactions using the two-nucleon pick-up mechanism of Glendenning. Spectroscopic information on ^{54}Mn levels up to 4.3 MeV excitation is obtained. (auth)

16946 PRECOMPOUND PROCESSES IN (α,n) REACTIONS. Alevra, A. (Inst. of Atomic Physics, Bucharest); Dumitrescu, R.; Lukas, I. R.; Magda, M. T.; Plostinaru, D.; Trutia, E.; Chevarier, N.; Chevarier, A.; Demeyer, A.; Tran Minh Duc. Nucl. Phys.; A209: No. 3, 557-571(30 Jul 1973).

Energy and angular distributions of neutrons emitted in (α,n) reactions on ^{56}Fe, ^{57}Fe, ^{103}Rh, ^{115}In, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn and ^{124}Sn at $E_\alpha = 20$ MeV were measured by the time-of-flight method. Data were analyzed in the framework of the pre-equilibrium model. Two alternative calculations, namely the Griffin–Blann and the hybrid models, were performed. Values of about 10% for the precompound fraction resulted from the analysis, in agreement with existing results. Different initial configurations consisting of three, four or five excitons were obtained, suggesting a systematic dependence on the neutron number of the target nucleus. (auth)

16947 INTERMEDIATE STRUCTURE IN THE NEUTRON SCATTERING CROSS SECTIONS OF IRON. Tomita, Y. (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys.; A210: No. 1, 51-59(1973).

Differential cross sections for the Fe(n,n), (n,n'), (n,n'γ) reactions were measured at incident energies between 1.43 and 2.15 MeV. Structure with intermediate widths was observed. The result was analyzed by the doorway-state model, and the widths of the assumed doorway states were obtained. Spin and parity assignment of $\frac{3}{2}^{(+)}$ was made to a doorway-state resonance at about 2.0 MeV. (auth)

16948 INELASTIC ELECTRON SCATTERING FROM EVEN SINGLE-CLOSED-SHELL NUCLEI. Phan-Xuan-Ho (CEN de Saclay, Gif-sur-Yvette, France); Bellicard, J.; Leconte, P.; Sick, I. Nucl. Phys.; A210: No. 1, 189-210(1973).

A systematic study of collective states excited by 209-MeV inelastic electron scattering in even single-closed-shell nuclei is presented. The nuclei studied are ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{90}Zr, ^{92}Mo, ^{116}Sn, ^{120}Sn and ^{124}Sn. The experimental results are compared with the theoretical microscopic vibrational model. A discussion of the normalization and the shape of the form factor is given. (auth)

16949 EFFECTIVE INTERACTIONS AND THE $1f_{\frac{7}{2}}$ SUB-SHELL CLOSURE IN THE 2p–1f SHELL. Sharma, S. K.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Phys. Lett.; 44B: No. 6, 491-493(11 Jun 1973).

It is estimated that the ground state of ^{56}Ni as given by the Kuo–Brown effective interaction modified to satisfy the restrictions imposed by the E2 systematics contains about 13 particles in the $1f_{\frac{7}{2}}$ shell. (auth)

16950 E2 TRANSITION SYSTEMATICS IN THE 1F–2P SHELL: A CONSTRAINT ON THE EFFECTIVE INTERACTION. Sharma, Satish; Bhatt, Kumar (Physical Research Laboratory, Ahmedabad-9, India). Phys. Rev. Lett. 30: No. 13, 620-623 (26 Mar 1973).

We discuss a constraint put by the E2 transition systematics in the 1f–2p shell on the effective two-body interaction in the shell. Some simple modifications in the Kuo–Brown effective interaction are made which tend to make it satisfy this constraint. (auth)

16951 ACCURATE MEASUREMENT OF THE POSITRON ASYMMETRY FROM ORIENTED ^{58}Co. Andrews, H. R.; Cohen, E. J.; Knott, T. F.; Pipkin, F. M. (Lyman Laboratory, Harvard University, Cambridge, Massachusetts 02138); Santry, D. C. Phys. Rev. C 7: No. 5, 1851-1864 (May 1973).

An accurate measurement of the asymmetry of the 2^+–2^+ 474-keV

positron group emitted by oriented ^{58}Co is reported. The ^{58}Co source, which had been ion implanted into an iron foil, was cooled to about 0.013°K by thermal contact with a demagnetized chromium potassium sulphate salt pill. The positrons were detected in a semiconductor detector telescope which reduced corrections for backscattering and γ-ray response. A complete description of the detector system and its operation is given. The accuracy of the result reported here is such that it is the first rigorous independent test of the commonly applied β-γ circular-polarization-correlation technique. The asymmetry parameter was found to be $A_1 = 0.243 \pm 0.007$ which corresponds to a Fermi-Gamow-Teller mixing ratio $C_V M_F / C_A M_{GT} = -0.0063 \pm 0.0056$. This result is discussed in terms of possible second-forbidden corrections and used to derive a value for the Fermi matrix element and to determine the isospin mixing of the analog of the daughter in the parent ground state of ^{58}Co. (auth)

16952 ENERGY DEPENDENCE OF THE ^{51}V(p,n)^{51}Cr ANALOG TRANSITION BETWEEN 16 AND 26 MeV. Wong, C.; Anderson, J. D.; Davis, J. C.; Grimes, S. M. (Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Rev. C 7: No. 5, 1895-1900 (May 1973).

Utilizing the recently completed cyclograaff facility, we have measured the angular distribution of the ^{51}V(p,n)^{51}Cr analog transition between 16 and 26 MeV. Between 21 and 26 MeV the integrated cross section decreases monotonically with increasing energy while between 16 and 21 MeV a broad resonant behavior is observed. Coupled-channel calculations, with isospin strengths linearly scaled up 1.5% per MeV from the optimum values deduced at 26 MeV, provide a good description of the measurements between 21 and 26 MeV. However, in the region of the apparent resonance the measurements are systematically higher than the calculations at the backward angles, implying a correlation between the appearance of the broad structure and the increase of cross section at the backward angles. Similarly, search routines on the isospin strengths produced a significant improvement in the fits only between 21 and 26 MeV. Between 21 and 16 MeV, the isospin strengths increase to account for the increasing total cross section but the quality of the fits is essentially unchanged. Thus, the most likely explanation for the resonant behavior is not an energy dependence of the isospin strengths, but the presence of an additional reaction mechanism which yields either an isotropic or symmetric incoherent contribution to the (p,n) analog transition. (auth)

16953 STUDY OF V, Mn, AND Co ISOTOPES. Parikh, Jyoti K. (Atomic Minerals Division, NPL Building, Hillside Road, New Delhi-12, India). Phys. Rev. C 7: No. 5, 1864-1870 (May 1973).

Nuclei with odd number of protons are studied using the Hartree-Fock-Bogoliubov method. The binding energies, single-particle spectra, quadrupole moments, B(E2) values, and the pickup strengths are calculated. By comparing the results for the neighboring even nuclei one can study the sets of isotones. The nuclei with N=26 (^{48}Ti, ^{49}V, ^{50}Cr, ^{51}Mn, and ^{52}Fe), N=28 (^{50}Ti, ^{51}V, ^{52}Cr, ^{53}Mn, ^{54}Fe, and ^{55}Co), and N=30 (^{53}V, ^{54}Cr, ^{55}Mn, ^{56}Fe, and ^{57}Co) are studied to understand the effects of the addition of a proton on the deformation, Fermi surface, fluctuations of the proton separation energies, pair separation energies, and the configuration mixing. (auth)

16954 PROPERTIES OF THE ARGON ISOTOPES. Gloeckner, D. H.; Lawson, R. D.; Serduke, F. J. D. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 7: No. 5, 1913-1926 (May 1973).

The properties of the low-lying states of the argon isotopes $^{39}_{18}Ar_{21}$, $^{40}_{18}Ar_{22}$, $^{41}_{18}Ar_{23}$, and $^{42}_{18}Ar_{24}$ are predicted by use of both the $(\pi d_{3/2})^2 (\nu f_{7/2})^n$ model and the extended $(\pi d_{3/2})^2 (\nu f_{7/2}, \nu p_{3/2})^n$ description. The n-n, p-p, and n-p interactions are taken from data on neighboring nuclei. With the extended model, reasonable agreement with experiment is obtained for the spectra. E2 and M1 transition rates are examined. All M1 transitions are predicted to be substantially inhibited, as is observed experimentally. Several experiments are suggested. (auth)

16955 SCATTERING OF 139-MeV ALPHA PARTICLES BY ^{58}Ni AND ^{208}Pb. Goldberg, D. A.; Smith, S. M.; Pugh, H. G.; Roos, P. G.; Wall, N. S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). Phys. Rev. C 7: No. 5, 1938-1950 (May 1973).

The elastic and inelastic scattering of α particles by ^{58}Ni and ^{208}Pb has been investigated at an incident energy of 139 MeV. The elastic cross sections have been analyzed in terms of the optical model using a six-parameter Woods-Saxon potential. The data for ^{58}Ni are sufficient to eliminate the discrete ambiguity in the strength of the potential; the single potential which fits the data has a well depth of 116 MeV and a volume integral J/4A of 298 MeV fm^3. For ^{208}Pb the discrete ambiguity could not be resolved. This outcome is consistent with recently developed criteria for experimental data necessary to resolve the discrete ambiguity. A discussion of the discrete ambiguity, in particular the A dependence, is given, and it is shown that measurements at higher energies are required to resolve the ambiguity for ^{208}Pb. The inelastic cross sections for transitions to the 1.45-MeV ($J^\pi = 2^+$), 2.46-MeV (4^+), 4.47-MeV (3^-) states in ^{58}Ni and the 2.62-MeV (3^-) state in ^{208}Pb have been analyzed with distorted-wave Born-approximation (DWBA) calculations using collective-model form factors. The results are consistent with previous analyses of lower-energy data. (auth)

16956 NUCLEAR CHARGE DISTRIBUTIONS OF ISOTONE PAIRS. II. ^{39}K AND ^{40}Ca. Sinha, B. B. P.; Peterson, G. A.; Whitney, R. R. (Department of Physics, University of Massachusetts, Amherst, Massachusetts 01002); Sick, I.; McCarthy, J. S. Phys. Rev. C 7: No. 5, 1930-1938 (May 1973).

Cross sections for electron elastic scattering from $^{39}_{19}$K and $^{40}_{20}$Ca are given for the momentum-transfer range from 0.6 to 3.4 fm^{-1}. The data were analyzed by means of a phase-shift code using phenomological Fermi charge distributions modified with small undulations. The difference of the ^{39}K and ^{40}Ca distributions has been compared with a $1d_{3/2}$ proton distribution and with other nuclear models. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 16865, 16866, 16907, 16939, 16971, 16981, 16987, 16996, 16999, 17003, and 17008.

16957 (BMFT-FBK-73-2, pp 55-58) DEFORMED NUCLEAR STATES IN ^{77}Br. Eberth, J.; Eberth, U.; Bretfeld, W.; von Brentano, P. Mar 1973. (In German).

16958 NEW N = Z ISOTOPE; KRYPTON 72. Schmeing, H.; Hardy, J. C.; Graham, R. L.; Geiger, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Phys. Lett.; 44B: No. 5, 449-452(28 May 1973).

Beta-delayed γ-rays were observed from the decay of ^{72}Kr ($\tau_{1/2} = 16.7 \pm 0.6$ s). A decay scheme is proposed based on γ-γ and β^+-γ coincidence measurements. The total decay energy was measured to be $Q_{EC} = 5057 \pm 135$ keV. The value is compared with mass predictions. (auth)

16959 ELASTIC ELECTRON SCATTERING FROM ^{88}Sr. Alster, Jonas (Department of Physics, Tel-Aviv University, Tel-Aviv, Israel); Gibson, B. F.; McCarthy, J. S.; Weiss, M. S.; Wright, R. M. Phys. Rev. C 7: No. 3, 1089-1098 (Mar 1973).

Differential elastic cross sections for the scattering of high-energy electrons from ^{88}Sr have been measured. The data have been analyzed in terms of phenomenological charge distributions at two values of the incident electron energy. Comparison was made between the empirical distributions and those predicted by a state-independent shell-model description of the nucleus. (auth)

16960 ISOBARIC ANALOG STATES IN ^{77}Br. Gray, J. W. Manhattan, KS; Kansas State Univ. (1972). 119p. University Microfilms Order No. 73-13, 345.

Thesis (Ph.D.).

Isobaric analog resonances of ^{77}Se were observed in ^{77}Br through the reaction ^{76}Se(p,p)^{76}Se. Excitation functions were determined at laboratory scattering angles of 160, 120, 90, and 60° for incident proton energies between 3.06 MeV and 4.55 MeV. Observed resonances were fitted using a Coulomb-plus-single-level formula, and the resonance energies, l values, total width, and proton partial widths were extracted. These parameters were then used to determine spectroscopic factors for the observed resonances. Spectroscopic factor ratios were also determined between resonances of the same l value. These ratios are compared with the spectroscopic factor ratios listed for the parent states to these analogs. A large disagreement is noted for the spectroscopic factor ratios for the l = 0 states in ^{77}Se and ^{77}Br. Ratios for l = 1 and l = 2 analog states in ^{77}Br are in agreement with similar ratios for the corresponding parent states in ^{77}Se. A possible explanation of the disagreement in the spectroscopic factor ratios between parent and analog l = 0 states is given. (RWR)

16961 INVESTIGATION OF THE ELECTRIC MONOPOLE TRANSITION IN ^{72}Ge. Nicaise, W. F. Raleigh, NC; North Carolina State Univ. (1972). 84p. University Microfilms Order No. 73-13,117.

Thesis (Ph.D.).

The half-life of the electric monopole transition in ^{72}Ge was measured by two independent delayed-coincidence counting methods. The first method employed a dual detector system consisting of a plastic scintillator to detect betas and a Ge(Li) gamma detector. The second method used a single detector system consisting of the plastic scintillation detector alone. In these measurements a small amount of ^{71}Ga was located internally in the plastic scintillator and could be periodically irradiated by neutrons to produce the ^{72}Ga source. The single detector system was found to be the more accurate. The best value obtained for the half-life was 418 ± 6 nanoseconds, in agreement with the most recent mea-

surements of the transition and with better accuracy. The nuclear strength parameter of the transition was calculated to be 0.103, which is one order of magnitude smaller than that predicted by either the strict single-particle or collective model of the nucleus. The dual detector timing system was used in coincidence with the gamma singles spectrum as a dual parameter "time probe" to determine those gamma transitions in coincidence with the decay of, and, hence, feeding, the 690-keV level of ^{72}Ge. These coincidences manifest themselves as sudden appearances of a decay curve above a random background at the appropriate gamma energies. Coincidences were found at gamma energies of 112.5, 142.5, and 230.6 keV. Finally, a high-resolution ORTEC Ge(Li) detector was used to obtain gamma-ray intensity measurements which rival in accuracy those obtained by the more sophisticated method of Compton suppression spectrometry. The intensities of 22 gamma transitions in the decay of ^{72}Ga were so obtained. (Diss. Abstr. Int., B)

16962 RESONANCE-FLUORESCENCE STUDIES. I. ^{45}Sc, ^{69}Ga, AND ^{71}Ga. Arnold, Raymond G.; Booth, Edward C.; Alston, William J. III (Boston University, Boston, Massachusetts 02215). Phys. Rev. C 7: No. 4, 1490-1500 (Apr 1973).

Resonant scattering of bremsstrahlung was used to measure $gW\Gamma_0\Gamma_0/\Gamma$ for 13 transitions in ^{45}Sc and 18 transitions in ^{69,71}Ga below 2.5 MeV. New level widths were measured by direct comparison of resonant scattering from levels of known width. Where branching ratios are known, radiative widths to the ground state Γ_0 are deduced. Comparisons are made between level widths measured in this work and in other measurements. The transition strengths in ^{69}Ga are compared with the most recent nuclear model. (auth)

16963 THE REACTIONS ^{63}Cu(p,n)^{63}Zn AND ^{63}Cu(p,2n)^{62}Zn FROM 1.5 GEV TO 11.5 GEV. Steinberg, Ellis P. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439); Winsberg, Lester. Phys. Rev. C 7: No. 4, 1410-1413 (Apr 1973).

Total cross sections for the ^{63}Cu(p,n)^{63}Zn and ^{63}Cu(p,2n)^{62}Zn reactions at 1.5, 2.0, 3.0, 4.5, 6.0, 9.0, and 11.5 GeV have been determined. These results are used to normalize previous differential recoil angular distribution data for the (p,2n) reaction at 1.0 GeV. A comparison with similar data for the ^{65}Cu(p,pn)^{64}Cu reaction indicates that, for energy transfers sufficient to evaporate only one nucleon, the inelastic (p,p') reaction is approximately 100 times more probable than the (p,n) interaction at this energy. (auth)

16964 ANALYSIS OF (p,t) AND (t,p) REACTION DATA FOR NICKEL ISOTOPES WITH STRUCTURE WAVE FUNCTIONS OF THE BROKEN-PAIR APPROXIMATION. Gambhir, Y. K. (International Centre for Theoretical Physics, Trieste, Italy); Rimini, A.; Weber, T. Phys. Rev. C 7: No. 4, 1454-1463 (Apr 1973).

The broken-pair-approximation (BPA) method is applied successfully to the even nickel isotopes. The BPA wave functions are generated in the configuration space containing four ($2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$, $1g_{9/2}$) valence single-particle orbitals by using the core-renormalized Tabakin interaction. These wave functions are used in the zero-range distorted-wave Born approximation for calculating spectroscopic amplitudes, form factors, angular distributions, and total cross sections for (p,t) and (t,p) reactions. The two-quasiparticle wave functions are also used in calculating these quantities for comparison. The theory gives in general a reasonably good account of the experimental data. (auth)

16965 A STUDY OF A NARROW RESONANCE 148 eV ABOVE THE ^{65}Cu(p,n)^{65}Zn REACTION THRESHOLD. Kneff, D. W.; Clarkson, R. G.; Lefevre, H. W. (University of Oregon, Eugene, Oregon, 97403). Phys. Rev. C 7: No. 4, 1645-1653 (Apr 1973).

A thick target time-of-flight technique has been used to measure near-threshold neutrons from the ^{65}Cu(p,n)^{65}Zn reaction. The neutron yield near threshold is dominated by a narrow 2$^-$ or 3-^{66}Zn resonance 148 eV above the 2.17-MeV reaction threshold. The c.m. angular distribution of resonance neutrons is isotropic to within 10%. Neutrons from this resonance lie within a forward cone of half angle 32° and have laboratory energies of 1180.9 ± 4.6 and 107.6 ± 0.6 eV for 0 and 180° c.m. angles, respectively. These energies, when combined with the known masses and reaction Q value, indicate a velocity decrease of 0.7% for the recoiling compound system before neutron decay. The product of the peak cross section and resonance width is 600 ± 50mb eV, and the width is between 2 and 10 eV. Detailed balance predicts a ^{65}Zn(n,p)^{65}Cu cross section on the order of 1000b at 144-eV neutron energy. (auth)

16966 HALF-LIVES OF EXCITED STATES IN ^{77}As, ^{97}Tc AND ^{192}Os. Chopra, R. C.; Tandon, P. N.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A209: No. 3, 461-469(30 Jul 1973).

The half-lives of the excited states in ^{77}As (264 keV, $5/2^-$), ^{97}Tc (216 keV, $7/2^+$ and 325 keV, $5/2^+$), and ^{192}Os (206 keV, 2^+) were measured to be 0.35 ± 0.02, ≤0.15, 0.37 ± 0.02 and 0.30 ± 0.02 ns, respectively, using the delayed coincidence technique. The M1 retardation and E2 enhancement factors were deduced and are compared with systematics of the neighboring nuclei. (auth)

16967 SHELL MODEL IN THE CONTINUUM ANALYSIS OF ANALOGUE RESONANCES IN ^{89}Y(p,p')^{89}Y*. Dalton, B. J.; Robson, D. Nucl. Phys.; A210: No. 1, 1-18(1973).

Excitation functions for the reactions ^{89}Y(p,p')^{89}Y* leading to the second and third excited states of ^{89}Y are calculated. The levels of ^{90}Y are calculated by using a simple configuration-mixing shell model and converted into analog resonances by using a many-level multichannel R-matrix approach. The nonanalog component of the inelastic scattering is described via Hauser–Feshbach theory, and the effects of mixing of isospin on this compound contribution are investigated. Comparison with the previously published experimental results yields tentative spin and parity assignments for the analog resonances in ^{90}Zr. (5 figures, 3 tables) (auth)

16968 STUDY OF THE ENERGY LEVELS OF ^{69}Ga USING NUCLEAR PHOTOEXCITATION. Moreh, R.; Shahal, O.; Tenenbaum, J.; Wolf, A.; Nof, A. (Nuclear Research Center-Negev, Beer Sheva, Israel). Phys. Rev. C 7: No. 5, 1885-1894 (May 1973).

Elastic and inelastic scattering of monochromatic photons were used for studying nuclear energy levels in Ga^{69}; the photons were produced by thermal neutron capture in copper and vanadium. The decay of one resonance at 7306 keV excited by the copper γ source and another resonance at 6874 keV excited by the vanadium γ source were studied in detail and 30 low-lying levels were observed from the ground state up to 3.4 MeV, 17 of which are believed to be new levels in ^{69}Ga. The angular distribution of some elastic and inelastic lines were measured and the following spin determinations were made (keV, J^π): 320, 1/2 , (3/2); 574, 5/2 ; 872, 3/2 ; 1488, 3/2 , 7/2 ; 1525 (1/2, 3/2); 1891, 3/2 ; 1978, (1/2, 3/2); 2457, 3/2; 2484, 5/2; (2565), (1/2, 3/2); 2660, 3/2; 3051, (3/2, 7/2); 3076, 5/2; 3318, (7/2); 6874, $1/2^{(+)}$ and 7306, $5/2^+$, where parentheses denote uncertain J^π assignments. The parity of the 7306-keV level was directly determined using a Compton polarimeter. The total radiative width of the 7306-keV level has measured and found to be $\Gamma=0.105\pm0.020$ eV. For the 6874-keV level, a positive correlation coefficient was obtained, $\rho=0.69$, between the (γ,γ') and (d,n) transition strengths leading to the same final states in ^{69}Ga. The levels of ^{69}Ga are compared with recent theoretical calculations. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 15178, 15617, 15852, 16866, 16926, 16946, 16948, 16966, 16967, and 17025.

16969 (AEEW-M-1191) MINIGAL OUTPUT FROM UK NUCLEAR DATA LIBRARY: NDL1 (1973) THERMAL CROSS-SECTIONS, RESONANCE INTEGRALS AND FISSION SPECTRUM AVERAGES. Pope, A. L.; Story, J. S. (Atomic Energy Establishment, Winfrith (England)). Apr 1973. 20p. Dep. NTIS (U. S. Sales Only) $3.00.

A tabulation is given, calculated and printed by the program MINIGAL from all neutron cross-section data files in the main tape (NDL1) of the March 1973 edition of the UK Nuclear Data Library, of cross-section values for neutrons of 0.025298 eV; thermal-neutron cross sections averaged over a Maxwellian neutron spectrum with kT =0.025298 eV; epithermal (resonance) integrals over a 1/E neutron flux distribution from 0.55 eV to 2 MeV; the fission spectrum-averaged cross sections, calculated by using the Watt–Cranberg form for the prompt fission neutron spectrum from thermal-neutron-induced fission of ^{235}U. (auth)

16970 (BMFT-FBK-73-2) ANNUAL REPORT, 1970/1971. Gruhle, W. (Cologne Univ. (West Germany). Institut fuer Kernphysik). Mar 1973. 146p. (In German). Dep. NTIS (U. S. Sales Only) $9.50.

The research report for 1970/1971 of the Cologne Tandem accelerator is concerned with reaction and scattering experiments. The main topics are 3-particle reactions, excitation functions of light compound nuclei and isobaric analog states in medium-weight nuclei. In addition, nuclear spectroscopy, channeling experiments and several scientific-technical developments are described including a variety of computer programs. (80 figures) (auth)

For title listing of selected papers see: 15612–15614, 16216, 16842–16844, 16860–16864, 16905, 16906, 16957, 16971–16977, 17025, and 17066.

16971 (BMFT-FBK-73-2, pp 36-40) PROTON ELASTIC SCATTERING ON MEDIUM HEAVY NUCLEI. Berg, G.; Schieck, H.; Schulte, K.; von Brentano, P. Mar 1973. (In German).

16972 (BMFT-FBK-73-2, pp 42-47) POLARIZATION INVESTIGATIONS OF ISOBARIC ANALOG RESONANCES IN ^{127}I, ^{129}I, AND ^{131}I. Bangert, R.; Gonsior, B.; Moore, G.; Roth, M.; Steinmetz, B.; Stroemich, A. Mar 1973. (In German).

16973 (BMFT-FBK-73-2, pp 48-52) PROTON INELASTIC SCATTERING ON ^{126}Te, ^{128}Te, AND ^{130}Te OVER ISOBARIC ANALOG STATES. Bangert, R.; Gonsior, B.; Roth, M.; Steinmetz, B.; Stroemich, A. Mar 1973. (In German).

16974 (BMFT-FBK-73-2, pp 52-54) SCATTERING REACTIONS (p,n$\bar{p}$) ON ISOTOPES OF Sn AND Te. Bangert, R.; Gonsior, B.; Roth, M.; Steinmetz, B.; Stroemich, A. Mar 1973. (In German).

16975 (BMFT-FBK-73-2, pp 61-65) SUB- AND QUASI-COULOMB STRIPPING ON THE ISOTOPES ^{124}Sn, ^{130}Te, ^{138}Ba, ^{140}Ce, ^{142}Nd, ^{208}Pb. Bangert, R.; von Brentano, P.; Gonsior, B.; Roth, M.; Steinmetz, B.; Stroemich, A. Mar 1973. (In German).

16976 (BMFT-FBK-73-2, pp 70-71) DETERMINATION OF STATIC QUADRUPOLE MOMENTS OF Cd AND Te ISOTOPES THROUGH COULOMB EXCITATION. Kleinfeld, A.; Werdecker, D. Mar 1973. (In German).

16977 (BMFT-FBK-73-2, pp 128-131) MEASUREMENT OF SHORT LIFETIMES OF ISOMERIC STATES. Kleinofen, D.; Schulte, K. Mar 1973. (In German).

16978 (INR-1458) STUDY OF THE ^{115}In(p,α)^{112}Cd REACTION AT PROTON ENERGY 14 MeV. Turkiewicz, I. M. (Institute of Nuclear Research, Warsaw (Poland)). 1973. 10p. Dep. NTIS (U. S. Sales Only) $3.00.

The energy spectra of α particles from the reaction ^{115}In(p,α)^{112}Cd were measured at proton energy E_p = 14 MeV. The discussion of the experimental results in the frame of current nuclear reactions models is given. (auth)

16979 (LA-tr-73-11) FISSION PRODUCT DATA LIBRARY. Devillers, C.; Blachot, J.; Lott, M.; Nimal, B.; N'Guyen Van Dat; Noel, J. P.; de Tourreil, R. 1973. Translation of SM-170/63. (CONF-730302-13). 30p. Dep. NTIS $3.50.

From symposium on applications of nuclear data in science and technology; Paris, France (12 Mar 1973).

The authors describe how to compile all the data necessary for calculation of the concentrations and activity of β and γ produced by fission. This library, which conforms to the ENDF/B format, is based on compilation and evaluation of available data. It contains fission yields for the most usual fissions, isobar chain schemes, and transition probability tables and gamma spectra. Compilation and evaluation bear mainly on decay schemes, for which the following data were gathered from 622 isotopes (^{71}Zn to ^{170}Yb): period; Q_β (β decay energy), internal transition energy in case of isomerism; beta transition probability and beta energy; relative or absolute intensities of the gamma lines and their energy; and references. The authors present residual power measurements that validate the entire body of data gathered. (3 figures, 4 tables) (tr-auth)

16980 (LYCEN-7303) PRECOMPOUND PROCESSES IN (α,n) REACTIONS. Alevra, A.; Dumitrescu, R.; Lukas, I. R.; Magda, M. T.; Plostinaru, D.; Trutia, E.; Chevarier, N.; Chevarier, A.; Demeyer, A.; Tran Minh Duc (Lyon Univ. (France). Institut de Physique Nucleaire). Jan 1973. 30p. Dep. NTIS (U. S. Sales Only) $3.50.

The energy and angular distributions of neutrons emitted in (α,n) reactions on ^{56}Fe, ^{57}Fe, ^{103}Rh, ^{115}In, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{119}Sn, and ^{124}Sn at 20 MeV were measured by the time-of-flight method. Data were analyzed in the framework of Griffin's pre-equilibrium model. An analysis based on the hybrid model was also performed. Values of about 10% were obtained for the precompound fraction; this is in agreement with existing results. Different initial configurations consisting of three, four, or five excitons were obtained, suggesting a systematic dependence on the neutron number of the target nucleus. (auth)

16981 (RLO-1388-212) NUCLEON TRANSFER WITH OXYGEN IONS BELOW AND NEAR THE COULOMB BARRIER. Nair, K. G.; Blair, J. S.; Reisdorf, W.; Wharton, W. R.; Braithwaite, W. J.; Mehta, M. K. (Washington Univ., Seattle. Dept. of Physics). 1973. 51p. Dep. NTIS $4.75.

Excitation functions were measured at θ_{lab} = 170° for the reactions ^{140}Ce(^{16}O,^{15}N)^{141}Pr (E_{lab} = 56.0 to 63.0 MeV), ^{88}Sr(^{16}O,^{15}N)^{89}Y (42.5 to 50.0 MeV), and ^{140}Ce(^{18}O,^{17}O)^{141}Ce(56.0 to 61.0 MeV) proceeding to low excited states. Analysis was done by using the sub-Coulomb DWBA theory of Buttle and Goldfarb with inclusion of Coulomb correction terms in the form factor and the Buttle-Goldfarb approximation for recoil corrections. Good fits were obtained to the excitation functions at the lower energies. Normalization at these energies determined an essentially invariant quantity, namely, the joint probability for the transferred nucleon being at radius R_1 with respect to the first core nucleus and radius R_2 with respect to the second, where $R_1 \equiv \alpha\,[(A_1^{l_b} + A_2^{l_b})]\,A_2^{l_b}\,)]$ and $R_2 \equiv \alpha[A_2^{l_b}/(A_1^{l_b} + A_2^{l_b})]$, α being the distance of closest approach in a head-on collision averaged between incident and final channels. If specific assumptions are made for the geometrical parameters of the bound states, values can be extracted for the product of spectroscopic factors, $S^{(1)}\,S^{(2)}$, reasonable geometries lead to values of $S^{(2)}$ very close to those previously obtained from light-ion reactions. Above the barrier, the fits to calculations which use nuclear distorted waves are less satisfactory; for optical potentials which give nearly equivalent elastic scattering, the calculations show moderate ambiguity. The leading uncertainty in the analysis is believed to be due to the approximate treatment of recoil. (12 figures, 3 tables) (auth)

16982 EFFECT OF INELASTIC SCATTERING PROCESSES ON (p,t) REACTIONS EXCITING THE FIRST 2^+ STATES IN Te, Sn AND Cd ISOTOPES. Yagi, K. (Osaka Univ., Toyonaka); Aoki, Y.; Rangacharyulu, C.; Matoba, K.; Hyakutake, M.; Nidome, J. Phys. Lett.; 44B: No. 5, 447-448(28 May 1973).

Differential cross sections of (p,t) reactions exciting the 2_1^+ states in Te (A = 128 to 120), Sn (116 and 114) and Cd (114 and 112) were measured at E_p = 52 MeV. The observed differences of the angular distributions are interpreted by taking into account the two-step processes through inelastic scattering channels. (auth)

16983 ESTIMATE OF THE HINDRANCE FACTORS FOR γ-RAY TRANSITIONS NEAR THE NEUTRON BINDING ENERGY FROM THE REACTION ^{143}Nd(n,$\gamma\alpha$)^{140}Ce. Furman, W. I.; Niedzwiediuk, K.; Popov, Yu. P.; Rumi, R. F.; Salatsky, V. I.; Tishin, V. G.; Winiwarter, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 44B: No. 5, 465-467(28 May 1973).

The reaction ^{143}Nd(n,$\gamma\alpha$)^{140}Ce was investigated at the 55.3 eV resonance. A theoretical analysis was carried out, yielding lower limits for the hindrance factors of γ-ray transitions between highly excited states close to the neutron binding energy. Some evidence for the predominance of M1 transitions in this energy region was found. (auth)

16984 PROLATE DEFORMATION IN NEUTRON-DEFICIENT LANTHANUM ISOTOPES. Nakai, K. (Niels Bohr Inst., Copenhagen); Kleinheinz, P.; Leigh, J. R.; Maier, K. H.; Stephens, F. S.; Diamond, R. M.; Loevhoeiden, G. Phys. Lett.; 44B: No. 5, 443-446(28 May 1973).

The odd-A La isotopes from A = 125 to 13 were studied by in-beam γ-ray spectroscopy of Sn(^{14}N,xn)La reactions and from A = 131 to 139 by particle spectroscopy of the Ba(α,t)La and Ba(τ,d)La single-proton transfer reactions. In the latter experiments a low-lying $11/2^-$ level was systematically identified, and the rotational bands built on these levels were observed in the γ-ray work. The strong resemblance of the transition energies in these bands to the ground-band transitions in the neighboring even Ba isotopes is very striking. These results can be understood as a decoupling of an $h_{11/2}$ single proton from the Ba core. This interpretation of the observed bands requires a prolate deformation for these nuclei, which is in contrast to previous conclusions. (auth)

16985 γ-γ DIRECTIONAL CORRELATION MEASUREMENTS IN ^{106}Pd. Avignone, F. T. III; Pinkerton, J. E. (Department of Physics, University of South Carolina, Columbia, South Carolina 29208). Phys. Rev. C 7: No. 3, 1238-1246 (Mar 1973).

Eleven directional correlations of γ-ray cascades in ^{106}Pd were measured after the decay of 30-sec ^{106g}Rh. The following correlation coefficients were measured:

$A_{22}(873-616) = -0.103 \pm 0.010$	$A_{44}(873-616) = 0.350 \pm 0.025$
$A_{22}(1192-512) = 0.360 \pm 0.012$	$A_{44}(1192-512) = 1.230 \pm 0.022$
$A_{22}(1061-1128) = 0.46 \pm 0.07$	$A_{44}(1061-1128) = 0.30 \pm 0.13$
$A_{22}(1113-1128) = -0.37 \pm 0.06$	$A_{44}(1113-1128) = 0.19 \pm 0.05$
$A_{22}(1150-1128) = 0.20 \pm 0.05$	$A_{44}(1150-1128) = 1.33 \pm 0.20$
$A_{22}(1178-1128) = 0.24 \pm 0.03$	$A_{44}(1178-1128) = 1.00 \pm 0.15$
$A_{22}(1766-512) = 0.28 \pm 0.07$	$A_{44}(1766-512) = 1.90 \pm 0.50$
$A_{22}(1796-512) = 0.20 \pm 0.03$	$A_{44}(1796-512) = -0.01 \pm 0.14$
$A_{22}(1925-512) = 0.22 \pm 0.08$	$A_{44}(1925-512) = 0.24 \pm 0.08$
$A_{22}(1988-512) = 0.24 \pm 0.13$	$A_{44}(1988-512) = 0.30 \pm 0.13$
$A_{22}(2112-512) = 0.44 \pm 0.15$	$A_{44}(2112-512) = 1.60 \pm 0.50$

where the directional correlation function is given by $W(\theta) = 1 + A_{22}P_2(\cos\theta) + A_{44}P_4(\cos\theta)$. The following E2/M1 multipole mixing ratios were determined: $-53 \le \delta$ (616) ≤ -15, δ (1061) $= 1.20 \pm 0.15$, δ (1113) ≈ -1.5, $1.9 \le \delta$ (1925) ≤ 3.5, and $1.5 \le \delta$ (1988)

≤ 4. The levels at 2189, 2241, 2437, and 2500 keV are each assigned a spin of 2 on the grounds of four observed 2–2–0 correlations, and levels at 1704, 2278, 2306, and 2624 keV are each assigned a spin of 0 on the grounds of five observed 0–2–0 correlations. The levels from this and previous work are compared with those calculated with the vibrational model of Ferreira and his co-workers up through the four-phonon energy region. (auth)

16986 DECAY OF 1.65-H ^{95}Ru TO LEVELS IN ^{95}Tc. Xenoulis, Alexander C.; Sarantites, Demetrios G. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). Phys. Rev. C 7: No. 3, 1193-1206 (Mar 1973).

The level structure of ^{95}Tc has been investigated from the decay of 1.65-h ^{95}Ru. Singles γ-ray energy and intensity measurements were taken with a 42-cm^3 high-resolution Ge(Li) detector in an anti-Compton arrangement which employed a large NaI(Tl) annular detector. Energies and intensities have been determined for 81 γ rays which have been observed to decay with the half-life of the ^{95}Ru isotope. Extensive γ-γ coincidence Ge(Li) -Ge(Li) measurements have been utilized to establish γ-γ coincidence relationships. The transitions to the ground and metastable state were identified from Ge(Li) -NaI(Tl) anticoincidence measurements. A decay scheme accommodating 71 transitions between 21 levels is proposed. The levels at 2168.2, 2189.0, 2267.5, and 2382.0 keV have not previously been reported. From deduced log ft values and measured γ-ray branching ratios definite J^π assignments were made to a number of levels and limits for the J^π values were placed for the rest of the levels in ^{95}Tc. The level structure of the ^{95}Tc isotope is examined and compared with spectra derived on the basis of extended pairing-plus-quadrupole and shell-model calculations. (auth)

16987 ANOMALOUS PARITY STATES IN $g_{\frac{9}{2}}$-SHELL NUCLEI AND THE THANKAPPAN-TRUE CORE-COUPLING HAMILTONIAN. A Goswami; D. K. McDaniels (Department of Physics, University of Oregon, Eugene, Oregon 97403); O. Nalcioglu. Phys. Rev. C 7: No. 3, 1263-1266 (Mar 1973).

It is shown that the observed features of the anomalous parity states in $g_{9/2}$-shell odd-mass nuclei can be qualitatively explained if core-quasiparticle coupling interactions of the type $-\lambda\vec{J}_c \cdot \vec{j}_{qp}$ and $\chi\vec{Q}_c \cdot \vec{Q}_{qp}$ are taken into account. (auth)

16988 SHORT-LIVED ISOMERS OF ^{148}Tb AND ^{147}Tb. Bowman, W. W.; Haenni, D. R.; Sugihara, T. T. (Cyclotron Institute and Department of Chemistry, Texas A&M University, College Station, Texas 77843). Phys. Rev. C 7: No. 4, 1686-1690 (Apr 1973).

A 2.5-min activity previously assigned to ^{147}Tb is shown to be 2.10 ± 0.05-min ^{148}Tb. Levels are proposed in ^{148}Gd at 784.48, 1273.31, 1416.35, 1754.96, 1810.90, 2563.8, and 1693.31 keV. The decay of this ^{148}Tb activity occurs almost entirely to a single high-lying, high-spin level in ^{148}Gd. A short-lived ^{147}Tb isomer is found to have a half-life of 1.83 ± 0.06 min and prominent γ rays of energy 1397.3 and 1798.0 keV. (auth)

16989 RESONANCE-FLUORESCENCE STUDIES. II. ^{121}Sb AND ^{123}Sb. Booth, Edward C.; Arnold, Raymond G.; Alston, William J. III (Boston University, Boston, Massachusetts 02215). Phys. Rev. C 7: No. 4, 1500-1509 (Apr 1973).

Resonant scattering of bremsstrahlung was used to measure the scattering widths $gW\Gamma_o\Gamma_i/\Gamma$ for 43 transitions in the antimony isotopes ^{121,123}Sb between 0.5 and 2.5 MeV. Absorption measurements determined $g\Gamma_o$ in seven cases. Comparison of the scattering widths with the B(E2) values from Coulomb excitation gave the mixing ratios in five cases. The theoretical level schemes and B(E2) calculations using the unified model up to second order in the collective variable had some success in explaining the experimental results. (auth)

16990 LEVEL STRUCTURE OF ^{102}Pd INVESTIGATED BY $(\alpha,xn;\gamma)$ REACTIONS. Simms, P. C.; Anderson, R.; Rickey, F. A.; Smith, G.; Steffen, R. M.; (and others) (Tandem Accelerator Laboratory, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 7: No. 4, 1631-1644 (Apr 1973).

Levels in ^{102}Pd have been investigated by utilizing the ^{99}Ru$(\alpha,n;\gamma)$ ^{102}Pd reaction. The basic measurements were γ-ray excitation functions, angular distributions, and γ-γ coincidences. All γ-ray measurements were performed with Ge(Li) detectors. The excitation functions were used to identify ^{102}Pd γ rays, and the coincidence measurements were used to construct a level scheme. Nuclear spins have been inferred from analysis of the angular distributions. The proposed level scheme contains 24 levels; the dominant γ-ray cascade connects states of spin 0^+, 2^+, 4^+, 6^+, 8^+, and 10^+. (auth)

16991 NEUTRON EMISSION FOLLOWING MUON CAPTURE IN ^{142}Ce, ^{140}Ce, ^{138}Ba, AND ^{120}Sn. Lucas, G. R. Jr.; Martin, P.; Miller, G. H.; Welsh, R. E. (College of William and Mary, Williamsburg, Virginia 23185); Jenkins, D. A.; (and others). Phys. Rev. C 7: No. 4, 1678-1686 (Apr 1973).

Branching ratios to excited nuclear states formed after muon capture have been measured with Ge(Li) detectors. The delayed γ rays were observed in studies of muonic ^{142}Ce, ^{140}Ce, ^{138}Ba, and ^{120}Sn, using separated isotopes. The resulting isotopes formed indicate at least a 60% probability of neutron emission upon muon capture, with the most likely product resulting from single-neutron emission. No evidence for delayed proton emission with a probability higher than 2% was found. Using our more precise energies for the observed nuclear transitions, we present revised energy level schemes for ^{141}La, ^{139}La, ^{137}Cs, and ^{119}In. (auth)

16992 SEARCH FOR THE NUCLEAR ELECTRIC HEXADECAPOLE MOMENT OF ^{115}In BY MOLECULAR-BEAM ELECTRIC-RESONANCE SPECTROSCOPY. Robert H. Hammerle; Zorn, Jens C. (Randall Laboratory of Physics, The University of Michigan, Ann Arbor, Michigan 48104.). Phys. Rev. C 7: No. 4, 1591-1596 (Apr 1973).

This experiment with a molecular-beam electric-resonance spectrometer determined the hyperfine structure of indium fluoride, ^{115}In^{19}F, to an accuracy of 1 part in 10^6. The experiment was an attempt to observe the interaction of a nuclear electric hexadecapole moment of ^{115}In that a simple order of magnitude calculation and a previous experiment showed might barely be observable. Although a hexadecapole interaction energy larger than 500 Hz could have been detected, no evidence of the interaction was found. To understand this result, the electric hexadecapole moment was calculated on the basis of a model in which the nuclear electric charge density was assumed to be uniform within a surface defined by $r(\theta,\phi) = R_0[1+\beta_2P_2(\cos\theta)+\beta_4P_4(\cos\theta]$, where β_2 and β_4 are taken to have the same values as the corresponding parameters for the nuclear potential. The value of the hexadecapole interaction energy ^{115}In^{19}F predicted by the model is 10 Hz, well below the limit of detectability with the spectrometer employed in the experiment. (auth)

16993 ENERGY SPECTRA OF FRAGMENTS FROM SILVER AND URANIUM BOMBARDED WITH 5.0-GEV PROTONS. Korteling, Ralph. G.; Toren, C. R. (Department of Chemistry, Simon Fraser University, Burnaby, British Columbia, Canada); Hyde, Earl K. Phys. Rev. C 7: No. 4, 1611-1626 (Apr 1973).

In this third paper in a series in which the characteristics of nuclear fragments produced in the interaction of 5-GeV protons with Ag and U targets were studied by means of dE/dx-E measurements with semiconductor detector telescopes new information was obtained on the energy spectra of light fragments. One set of measurements on fragments from a Ag target involved the use of a two-element telescope incorporating a ΔE detector as thin as 16 μm. A new algorithm for processing the ΔE and E data to extract particle identification was developed and the resulting particle spectra showed superior resolution for the elements from Li ($Z=3$) to S ($Z=16$). Segments of the energy spectra of each of these elements were measured at 20° and, for many of them, also at 45, 90, 135, and 160° to the beam direction. By use of three-element telescopes and absorbers the high-energy part of the energy spectrum for isotopes of He, Li, Be, B, and C ejected from Ag and U targets was measured at 20°. The measurements extended beyond 300 MeV for ^{6}Li and ^{7}Li and to 400 MeV for ^{7}Be. A distinct high-energy component was found in these cases. The suitability of nuclear evaporation as a description of the emission of the low-energy fragments was tested with two simple theoretical models, one specifying isotropic fragment emission from a moving nucleus at a fixed nuclear temperature and one specifying isotropic fragment emission from a set of moving nuclei with a Maxwellian distribution of excitation energies and forward momenta. The second could describe rather well all the 90° data, provided a Coulomb barrier 0.4 that of the classical tangent-spheres barrier was used. However, the measured intensity in the forward direction was much higher than predicted. Neither evaporation calculation was able to describe the highest-energy part of the spectra, and the conclusion was drawn that these particles must be produced in the initial high-energy cascade. (auth)

16994 FAST NEUTRON SCATTERING AT 180°. Gupta, M. C. Pullman, WA; Washington State Univ. (1973). 73p. University Microfilms Order No. 73-14,754.

Thesis (Ph.D.).

A technique for the measurement of the differential scattering cross section at 180° for neutrons and charged particles was developed. The 3.65-MeV neutron scattering cross section at 180° for Pb and Sn was measured using the associated-particle method. Dual-parameter pulse height analysis was used to obtain a coincidence time resolution of 6 ns between the detected neutrons and the associated ^{3}He recoil particles by taking into account the variations in flight times of ^{3}He particles. Theoretical calculations were made for the differential scattering cross section using the optical model. The compound elastic scattering cross section was calculated using the Hauser-Feshbach theory. Experimental values for the scattering cross section at 180° were 958 mb/sr and 268 mb/sr for Pb and Sn respectively. The theoretical values for the scattering cross section at 180° were 330 mb/sr and 55 mb/sr Pb and Sn. These experimental values were about three times more than the theoretical values. (Diss. Abstr. Int., B)

16995 NEUTRON SHELL STRUCTURE IN ^{93}Zr, ^{95}Zr, AND ^{97}Zr BY (d,p) AND (α,^{3}He) REACTIONS. Bingham, C. R. (The University of Tennessee, Knoxville, Tennessee 37916); Fabian, G. T. Phys. Rev. C 7: No. 4, 1509-1519 (Apr 1973).

Differential cross sections for ^{92,94,96}Zr(d,p) at 33.3 MeV were measured in 5° increments from 12.5 to 42.5° lab. The resolution was about 25 keV full width at half maximum. Many levels were characterized which were not reported or were improperly identified in previous neutron-transfer studies. (α, ^{3}He) spectra with 55-keV resolution were obtained at 15 and 20° for each target with 65.7-MeV α particles. The data were compared with distorted-wave calculations. With a few exceptions, consistent spectroscopic factors were obtained from the (d,p) and (α, ^{3}He) reactions. Sums of spectroscopic factors and centers of gravity are presented for levels assigned to $d_{5/2}$, $s_{1/2}$, $d_{3/2}$, $g_{7/2}$, and $h_{11/2}$ configurations in ^{93}Zr and ^{95}Zr. Except for the $h_{11/2}$ states, these sums are in good agreement with sum-rule predictions. Only ~50% of the expected $h_{11/2}$ strength was observed; the remainder appears to be highly fragmented and at excitation energies above 5 MeV. (auth)

16996 EFFECTIVE REACTION THRESHOLD FOR HEAVY-ION COLLISIONS. Holm, Hartmut (Institut für Theoretische Physik der Universität, Frankfurt/Main, Germany). Phys. Rev. C 7: No. 4, 1716-1717 (Apr 1973).

A new interpretation of the experimental results of H. Gauvin, Y. Le Beyec, M. Lefort, and C. Deprun published recently in Phys. Rev. Letters is given. The calculation of effective thresholds in a dynamical classical model for the reactions ^{40}Ar on ^{164}Dy and ^{84}Kr on ^{72}Ge and ^{116}Cd gives 139, 149.5, and 212 MeV to be compared with the experimental values of 135, 147, and 204 MeV. (auth)

16997 NEUTRON RESONANCE PARAMETERS OF ^{92}Mo. Wasson, O. A. (Brookhaven National Laboratory, Upton, New York 11973); Allen, B. J.; Winters, R. R.; Macklin, R. L.; Harvey, J. A. Phys. Rev. C 7: No. 4, 1532-1541 (Apr 1973).

Neutron transmission and total neutron capture yields were measured using the time-of-flight technique at the Oak Ridge Electron Linear Accelerator facility using enriched samples of ^{92}Mo. A total of 42 resonances were observed for neutron energies less than 32 keV. 12 are assigned to s-wave interactions while 23 are assigned to p-wave interactions. The resonant energies, neutron widths, radiation widths, and spins are deduced. The average s- and p-wave radiation widths are equal to 0.178 ± 0.015 eV and 0.24 ± 0.03 eV, respectively. The s-wave neutron strength function is $(0.65 \pm 0.26) \times 10^{-4}$ while the p-wave strength function is $(3.3 \pm 1.1) \times 10^{-4}$. (auth)

16998 SPINS OF THE LEVELS AND MULTIPOLE MIXING RATIOS OF THE TRANSITIONS IN ^{95}Mo. Behar, M.; Garber, D. A.; Grabowski, Z. W. (Purdue Univ., Lafayette, IN). Nucl. Phys.; A209: No. 3, 525-534(30 Jul 1973).

Directional correlations and polarization-directional correlations were measured for several γ-γ cascades in ^{95}Mo populated from the decay of ^{95}Tc. Two Ge(Li) detectors were used in the polarization measurements, and NaI(Tl)-Ge(Li) detectors were used in the directional correlation measurement. Combination of the results of these measurements give unique spin assignments of $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{1}{2}^+$ for the 786, 821, and 1039 keV levels, respectively. The determined E2/M1 mixing ratios are: $-19 \leqq \delta$ (219) $\leqq -0.6$, δ (582) $= +0.27^{+0.05}_{-0.04}$, δ (616) $= -(2.0 \pm 0.2)$ and δ (835) $= +0.04 \pm 0.02$. (auth)

16999 HALF-LIFE SYSTEMATICS OF β^- DECAY. Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta; 18: No. 3, 120-122(1972). (In German).

Equations for the calculation of partial half-lives of β^- decay are given for the whole mass region. By introduction of a mean excitation energy of the daughter nuclei, a much improved accuracy is obtained in comparison to Viola and Seaborg. (2 figures, 2 tables) (auth)

17000 EXCITED STATES IN THE TWO-NEUTRON-HOLE NUCLEUS $^{130}Sn_{80}$ OBSERVED IN THE 0.53 SEC β-DECAY OF ^{130}In. Kerek, A.; Holm, G. B.; Borg, S.; Carle, P. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A209: No. 3, 520-524(30 Jul 1973).

By studying high-energy β^- particles the 0.53 ± 0.05 sec decay of ^{130}In and excited states in the two-neutron-hole nucleus ^{130}Sn were observed. These states were given the tentative assignments 2^+ (1217 keV), 4^+ (1992 keV), and 5^- (2119 keV). (auth)

17001 MAGNETIC MOMENT OF THE 93-keV STATE OF ^{67}Zn BY THE NUCLEAR ZEEMAN EFFECT. Perlow, G. J.; Campbell, L. E.; Conroy, L. E.; Potzel, W. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. B 7: No. 9, 4044-4047 (1 May 1973).

Mössbauer measurements of the 93.26-keV transition in ^{67}Zn are reported for sources of ^{67}Ga in ZnO single crystals and ZnO powder as absorber. An external magnetic field of a few hundred oersteds is applied and the value of the magnetic moment of the $(1/2)^-$ first-excited state is determined by a quasinull method. We obtain $\mu[(1/2)^-] = +(0.58 \pm 0.03)\ \mu_N$. The electric field gradient is determined to be positive. (auth)

17002 NUCLEAR STRUCTURE STUDIES WITH (d,p) AND (d,t) REACTIONS ON ^{106}Cd. J. H. Degnan; G. R. Rao (Nuclear Physics Laboratory, University of Pittsburgh, Pittsburgh, Pennsylvania 15213). Phys. Rev. C 7: No. 5, 2131-2137 (May 1973).

Energy and angular distributions from (d,p) reactions induced by 12-MeV deuterons and (d,t) reactions induced by 16-MeV deuterons on ^{106}Cd were measured. Neutron l-transfer assignments, spin-parity assignments, and spectroscopic strengths were obtained for 25 of the 28 proton groups observed in ^{106}Cd (d,p) and for 3 of the 7 triton groups observed in ^{106}Cd (d,t). The ground-state Q value of ^{106}Cd (d,t) ^{105}Cd reaction was found to be -4.661 ± 0.05 MeV. (auth)

17003 E0 CONTRIBUTIONS IN 2^+ TO 2^+ TRANSITIONS IN ^{160}Dy, ^{134}Ba, ^{110}Cd, AND ^{82}Kr. Gardulski, P. L.; Wiedenbeck, M. L. (Department of Physics, The University of Michigan, Ann Arbor, Michigan, 48104). Phys. Rev. C 7: No. 5, 2080-2084 (May 1973).

A Ge(Li) - Ge(Li) directional-correlation system has been utilized to obtain directional-correlation functions for the 1-3 sequence, $I_i(L_1, L'_1)2(E0, M1, E2)2(L_3, L'_3)I_f$, in ^{160}Dy, ^{134}Ba, ^{110}Cd, and ^{82}Kr. The following E0 admixtures were determined: $T(E0)/T(E2_\gamma) \leq 0.010$ (^{160}Dy, 879 keV), $T(E0)/T(E2_\gamma) < 0.045$ (^{134}Ba, 563 keV), $T(E0)/T(E2_\gamma) = 0.097^{+0.139}_{-0.097}$ (^{110}Cd, 818 keV) and $T(E0)/T(E2_\gamma) = 0.009^{+0.073}_{-0.009}$ (^{82}Kr, 698 keV) In addition, combinations of NaI(Tl) and Ge(Li) detectors have been utilized to obtain mixing ratios for other transitions in the above nuclei. (auth)

17004 EXCITED STATES OF ^{94}Tc STUDIED THROUGH THE ENHANCEMENT OF NEUTRON AND GAMMA-RAY YIELDS FROM THE ^{94}Mo(p,n)^{94}Tc REACTION AT ISOBARIC-ANALOG RESONANCES. McPherson, M. R.; Gabbard, F. (Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506). Phys. Rev. C 7: No. 5, 2097-2108 (May 1973).

A revised and extended level scheme for ^{94}Tc results from the combined study of neutron and γ-ray spectra emitted at proton energies near isobaric-analog resonances. The cross sections for the ^{94}Mo(p,n)^{94}Tc reactions and relative yields of γ rays from the decay of the states of ^{94}Tc have been measured on the energy interval between 5.35 to 6.1 MeV in the vicinity of three analog resonances. The energies of neutrons emitted were measured by the time-of-flight technique. Excitation energies of levels in ^{94}Tc were determined from the neutron spectra and the energies of the γ rays observed. The enhancement of the neutron and γ-ray yields with measurements of neutron angular distributions has been compared with statistical model calculations. The results provide spin-parity assignments to a number of levels and suggest others. Of particular interest is the location of the 2^- and 3^- states separated by an energy of 142 keV. The results illustrate the use of the statistical analysis at isobaric-analog resonances according to the method of Robson for the extraction of spectroscopic information about nuclei. Comparison with shell-model calculations is given. (auth)

17005 MAGNETIC MOMENT OF THE 1.8-μs STATE IN ^{122}Sb. Heubes, P.; Ingwersen, H.; Klinger, W.; Lampert, W.; Loeffler, W.; (and others) (Physikalisches Institut der Universität Erlangen-Nürnberg, Erlangen, Germany). Phys. Rev. C 7: No. 5, 2128-2131 (May 1973).

The g factor of the first excited 3^+ state in ^{122}Sb at 61 keV was determined by the stroboscopic method. The experimental g factor $g = +0.988 \pm 0.004$ suggests the configuration $[\pi\ [\pi(g_{\frac{9}{2}})^1\ \nu(3s_{\frac{1}{2}})^1]_{3+}$ for this state. A remeasurement of the half-life yields the improved value $T_{\frac{1}{2}} = 1.86 \pm 0.08\ \mu s$. (auth)

17006 THE ^{90}Zr(p,p')^{90}Zr REACTION AT 40 MeV. Hinrichs, R. A.; Larson, D. (Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48823); Preedom, B. M.; Love, W. G.; Petrovich, F. Phys. Rev. C 7: No. 5, 1981-1995 (May 1973).

Differential cross sections for the excitation of the 0^+ (1.75-MeV), 2^+ (2.18-MeV), 5^- (2.32-MeV), 4^+ (3.08-MeV), 6^+(3.45-MeV), 8^+ (3.60-MeV), and the 2^+ (3.31-MeV) levels in ^{90}Zr by 40-MeV protons have been measured between 15° and 115°. The data are compared with the results of distorted-wave (DWA) collective-model calculations and DWA microscopic-model calculations. Both macroscopic and microscopic treatments of core polarization are considered. Effects from noncentral components in the projectile-target interaction have been investigated and an imaginary central component has been included in this interaction in the cases where a completely microscopic model is used for the target nucleus. A coupled channels calculation has been performed in order to investigate multiple excitation contributions to the cross section for the 0^+ (1.75-MeV) state. (auth)

17007 EXCITATION FUNCTIONS AND PHOTON EMISSION IN COMPOUND-NUCLEUS REACTIONS WITH HIGH ANGULAR MOMENTUM. Gilat, Jacob (Soreq Nuclear Research Center, Yavne, Israel); Jones, E. Roger III; Alexander, John M. Phys. Rev. C 7: No. 5, 1973-1980 (May 1973).

Measured excitation functions are compared to detailed evaporation calculations for the reactions $^{140}Ce(^{16}O,xn)^{156-x}Dy$, $^{144}Ne(^{12}C,xn)^{156-x}Dy$, $^{136}Ba(^{20}Ne,xn)^{156-x}Dy$ (x = 5,6,7), $^{154}Gd(^{4}He,xn)^{158-x}Dy$ (x = 7,8,9), and $^{181}Ta(^{4}He,xn)^{185-x}Re$ (x = 2,3,4). The agreement between theory and experiment is found to depend critically on the rate of photon emission within about 10 MeV of the yrast levels. For the first four systems above, good fits are obtained only when the γ-emission rate is strongly enhanced with respect to the rate indicated by the γ width of neutron resonances. γ enhancement by the following two methods leads to quite good fits to experiment: (1) a constant (independent of J) enhancement of a factor of 100 and (2) enhancement proportional to (2J + 1). For the system $^{181}Ta + {}^{4}He$ such pronounced enhancement does not seem to be required. These results are interpreted in terms of the structure of the γ-cascade band. At sufficiently high angular momenta, the γ-cascade band is predicted to give way to an α band. Possibilities are discussed (auth)

17008 RULES FOR SPIN AND PARITY ASSIGNMENTS BASED ON LOG FT VALUES. Raman, S.; Gove, N. B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 5, 1995-2009 (May 1973).

A survey was made of log ft values for forbidden β transitions. Three cases, ^{90m}Y, ^{63}Ni, and ^{144}Pm decays, were examined experimentally. A number of low log ft values reported in the literature are superseded by more recent larger values. Empirical rules for making spin and parity assignments from log ft values are proposed. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 16992, 16996, 16999, 17003, 17007, and 17094.

17009 (FRNC-TH-356) STUDY OF CERTAIN DYSPROSIUM AND HOLMIUM NUCLEI USING ON-LINE SPECTROSCOPY. Boutet, J. (Grenoble Univ. (France)). 1973. 122p. (In French). Dep. NTIS (U. S. Sales Only) $8.25.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

The decay $^{159}Ho \rightarrow {}^{159}Dy$ and the $(\alpha,3n\gamma)$ reaction on ^{159}Gd were used to study ^{159}Dy. Other experiments were also carried out in which the ^{157}Dy nucleus was obtained from the following reactions: $(\alpha,2n)$ on ^{155}Gd, $(\alpha,3n)$ on ^{156}Gd, and (p,3n) on ^{159}Tb. The existence of 3 rotation bands, $3/2^-[521]$, $11/2^-[505]$, and a positive-parity band, was established for each of these isotopes, the highest energy levels having spins of $17/2^-$, $23/2^-$, and $33/2^+$. The existence of two other bands in ^{159}Dy was also established: $5/2^-[523]$ and $5/2[512]$. The multipolarities were also determined. In each of these isotopes a positive-parity band, highly perturbed by Coriolis and $\Delta N = 2$ couplings, is observed. The tentative calculations made to explain the different couplings creating these particular structures are reviewed. The ground-state bands of the two isotopes ^{161}Ho and ^{159}Ho were studied using the two reactions $^{145}Sm(^{11}B,4n\gamma)$-$^{161}Ho$ and $^{159}Tb(\alpha,4n)^{159}Ho$. (FR)

17010 HOW INDIRECT (p,t) PROCESSES POPULATE THE γ-BAND OF ^{168}Yb. Landowne, S. (Univ. of Copenhagen); Broglia, R. A.; Neergaard, K. Phys. Lett.; 44B: No. 5, 425-428(28 May 1973).

Direct (p,t) transfer to the γ-band of ^{168}Yb is found to be less important than indirect processes involving collective quadrupole excitation and correlated l = 0 pair transfer. The 2^+_γ cross section can be explained by such processes but the 3^+_γ and 4^+_γ can not. Hexadecapole excitation to the 4^+_γ and the role of the unnatural parity of the 3^+_γ are discussed. (auth)

17011 ANALYSIS OF THE LEVELS OF ^{187}Os POPULATED BY THE (d,t) REACTION. Thompson, Roger; Sheline, R. K. (Physics Department, Florida State University, Tallahassee, Florida). Phys. Rev. C 7: No. 3, 1247-1254 (Mar 1973).

A study of the levels of ^{187}Os below 1500 keV excitation has been made with the (d,t) reaction. The states observed have been explained in terms of the unified model. The $(1/2)^-[510]$ and $(3/2)^-[512]$ bands have been fitted with strong Coriolis coupling. The $K - 2\ \gamma$ vibration built on the ground state has been observed. Tentative observation is made of the $K + 2\ \gamma$ vibration on the ground state and the $K - 2$ and $K + 2\ \gamma$ vibration built on the (3/2)-[512] band. Members of the (7/2)-[503], (11/2) + [615] and the (7/2)-[514] bands are identified. (auth)

17012 FIRST-FORBIDDEN BETA-DECAY MATRIX ELEMENTS IN ^{170}Tm. A. Khayyoom; Raju, M. L. Narasimha; Rao, V. Seshagiri; Sastry, D. L. (The Laboratories for Nuclear Research, Andra University, Waltair, India). Phys. Rev. C 7: No. 3, 1166-1173 (Mar 1973).

The directional correlation between once-forbidden nonunique 883-keV β and the 84-keV γ ray in the decay of ^{170}Tm has been measured as a function of β energy in the range 227 to 747 keV employing a fast-slow scintillation assembly. The attenuation of the correlation due to the finite lifetime of the intermediate state is determined by conducting an integral correlation experiment in both solid and liquid sources and is found to be about 30%. The present results on the directional correlation are combined with the nonallowed shape of the 883-keV β transition for the extraction of the matrix-element parameters. The relative sizes of the matrix-element parameters show that a cancellation of rank-1 matrix elements may be responsible for the observed behavior of the 883-keV β transition. The present matrix-element parameters are consistent with the description of Woods-Saxon wave functions characterizing the states. The results on conserved-vector-current (CVC) ratio are in accordance with the ideas due to Damgaard and Winther. The CVC ratio $(1/\xi)(\int 1\overline{\alpha}/\int \overline{1})$ is found to be $0.48 \leq (1/\xi)/(\int 1\overline{\alpha}/\int \overline{1}) \leq 0.81$, while the correction term, λ, $[= \int \overline{1}\ (r/R)^2/\int \overline{1}]$ in CVC ratio due to Damgaard and Winther is established to be 2.3. (auth)

17013 SPIN AND PARITY DETERMINATIONS IN TUNGSTEN NUCLEI USING POLARIZED DEUTERONS. Casten, R. F.; Keaton, P. W. Jr.; Lawrence, G. P. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 7: No. 3, 1016-1028 (Mar 1973).

States in the odd-mass isotopes of tungsten, $^{183,185,187}W$, have been studied by the W(d,p) reaction initiated by polarized deuterons of 12.08- and 15.0-MeV bombarding energy. Vector-analyzing-power angular distributions were obtained for the strongly excited states. The use of measured analyzing powers for states of known J^π as calibration standards for the assignment of new J^π value is discussed. This technique is found to be preferable, at the present stage, to a reliance on the distorted-wave Born approximation (DWBA). The phase, but not the magnitude, of the oscillations in the DWBA calculations for the vector-analyzing powers is in qualitative agreement with the data at 12 MeV for spins of $5/2$ or less. At 15 MeV, this is not the case. The dependence of the DWBA calculations on optical-model parameters and Q value is discussed. A number of spin-parity assignments or preferences are made. In particular, candidates for $1/2^-$ and $3/2^-$ states are located in each nucleus. The pairs of odd-parity levels are discussed as possible fragments of the first two members of the rotational band built on the $1/2^-[501]$ Nilsson orbital, but the difficulties associated with this assignment are also pointed out. (auth)

17014 MEASUREMENTS OF THE QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF ^{150}Sm AND ^{194}Pt BY THE REORIENTATION PRECESSION TECHNIQUE. Grodzins, L.; Herskind, B.; Sommayajulu, D. R. S. (The Niels Bohr Institute, Univeristy of Copenhagen, Copenhagen, Denmark); Skaali, B. Phys. Rev. Lett. 30: No. 10, 453-456 (5 Mar 1973).

We have observed the influence of the nuclear quadrupole moment on the γ-ray angular correlation following Coulomb excitation by heavy ions scattered through angles of about 90°. A prolate quadrupole moment precesses the γ-particle correlation in the opposite direction to that produced by a moment of oblate shape. The method has been applied to the first 2^+ states of ^{150}Sm and ^{194}Pt, which are found to be prolate, $Q = -1.25 \pm 0.2$ b, and oblate, $Q = +0.77 \pm 0.5$ b, respectively. (auth)

17015 STUDY OF ^{173}Hf LEVELS POPULATED IN THE DECAY OF ^{173}Ta. Rezanka, I.; Ladenbauer-Bellis, I. M.; Tamura, T.; Jones, W. B. (Heavy Ion Accelerator Laboratory, Yale University, New Haven, Connecticut 06520); Bernthal, F. M. Phys. Rev. C 7: No. 4, 1663-1677(Apr 1973).

The decay of ^{173}Ta was studied using high resolution Ge(Li), Si(Li), and Si surface-barrier detectors in singles and coincidence modes. The ^{173}Ta activity was produced via the reaction $^{165}Ho(^{12}C,4n)\ ^{173}Ta$, at a carbon beam energy of 6.3-6.9 MeV per nucleon. All spectra were obtained from chemically separated Ta sources. Besides the previously known energy levels of ^{173}Hf, the following levels in keV were determined: 255.5, 451.9, 508.9, 635.8, 775.5, 785.3, 811.7, 872.6, 927.5, 942.5, 1020.3, 1111.4, 1127.0, 1192.8, 1248.3, 1450.0, 1574.2, 1655.6, 1667.1, 1694.3, and 2263.3. Rotational bands based on the $(1/2)^-[521]$ (g.s.), $(5/2)^-[512]$ (107.2 keV), and $(7/2)^+[633]$ (197.5 keV) Nilsson states were observed. The half-lives of the $(5/2)^-[512]$ and the $(1/2)^+[633]$ band heads were determined to be (182 ± 20) nsec and (160 ± 40) nsec, respectively. The probability of the radiative E1 transition between the [633] and [512] band heads was calculated within the framework of Nilsson model including the pairing and Coriolis interactions. From measurement of the β^+ end-point energy, the mass difference between ^{173}Ta and ^{173}Hf was determined to be 3670 ± 200 keV. (auth)

17016 NUCLEAR QUADRUPOLE PRECESSION AFTER RECOIL IMPLANTATION INTO SINGLE CRYSTALS FOR ^{180}Hf IN Hf' AND ^{186}W IN Gd. Klepper, O. (Laboratory for Nuclear

Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Kaufmann, E. N.; Murnick, D. E. Phys. Rev. C 7: No. 4, 1691-1706 (Apr 1973).

Coulomb excitation with ^{16}O and ^{32}S beams was used to excite, polarize, and implant $^{180}Hf(2+)$ in Hf single crystals and $^{186}W(2+)$ in Gd single crystals. Particle–γ correlations for different crystal orientations were measured. The general features of the perturbed correlations were consistent with the prediction for a static axially symmetric quadrupole interaction in a single crystal, but additional perturbations had to be taken into account to explain the results quantitatively. Special experimental geometries were employed to separate these perturbations. In the ^{180}Hf in Hf experiment the sign of the quadrupole interaction could be unambiguously determined as negative using the known polarization of the excited nucleus. In the ^{186}W in Gd case unknown perturbation mechanisms reduced the terms linear in the quadrupole interaction frequency to such an extent that the negative sign indicated is less certain. Control experiments with implantation of ^{186}W in Cu foils were used to check the experimental technique for systematic errors. (auth)

17017 NUCLEAR ORIENTATION STUDIES OF THE DECAYS OF ^{187}W AND $^{185,191,193}Os$. Krane, K. S.; Steyert, W. A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. C 7: No. 4, 1555-1563 (Apr 1973).

Angular distributions have been measured for γ rays emitted following the decays of ^{187}W and $^{185,191,193}Os$ nuclei polarized at low temperatures in iron. The decay of polarized spin–1/2 nuclear levels was found to show isotropic angular distributions to three parts in 10^4, in keeping with angular momentum theory, and purity of the accepted nuclear spin values. The magnitudes of the magnetic moments of the ^{187}W and ^{193}Os ground states have been deduced to be (0.688 ± 0.021) μ_N and (1.30 ± 0.19) μ_N, respectively, assuming saturation of the hyperfine field at the nucleus; the magnitude of the magnetic moment of the ^{191}Ir 171–keV level has been similarly deduced to be (3.27 ± 0.12) μ_N, based in part on the observation that the nuclear spin–lattice relaxation time associated with decays from that level is less than 0.1 sec. E2/M1 multipole mixing ratios have been deduced for a number of ^{187}Re and ^{193}Ir γ rays, and the multipole characters of several of the β radiations emitted by ^{187}W and ^{193}Os have been obtained; these multipolarities are discussed in terms of the nuclear structure. The use of polarized ^{191}Os as an absolute γ ray anisotropy thermometer is discussed. (auth)

17018 ENERGY LEVELS OF ^{167}Er POPULATED BY THE (d,d′) REACTION. Sterba, F.; Sterbova, J.; Rozkos, M. (Charles Univ., Prague). Czech. J. Phys.; B23: No. 6, 601-614(1973).

Data on inelastic deuteron scattering from low-lying energy levels in ^{167}Er are presented as a supplement to an investigation of this nucleus by the (d,p) and (d,t) reactions. Deuterons with an energy of 12.1 MeV were scattered from an ^{167}Er target and recorded in a high-resolution magnetic spectrograph at angles of observation of 60°, 90°, 125°, and 150°. Absolute inelastic cross sections for several excited states were determined; they are discussed in terms of collective excitations and Coriolis coupling of the single-particle states. (auth)

17019 FEEDING TIMES IN (HI,xnγ) REACTIONS. Newton, J. O.; Stephens, F. S.; Diamond, R. M. (Univ. of California, Berkeley). Nucl. Phys; A210: No. 1, 19-28(1973).

Feeding times, T_f, for population of the quasi-rotational bands in a number of doubly even nuclei formed in (HI,xn) reactions were measured with the recoil-distance Doppler-shift technique. Values of 11 ± 3, 5 ± 2.5, 3 ± 3 and 12^{+5}_{-5} ps were obtained for T_f in the $^{166,168,170}Hf$ and ^{178}Os nuclei populated by the $^{150,152,154}Sm(^{20}Ne,4n)$ and $^{154}Sm(^{28}Si,4n)$ reactions, respectively. In all cases the fraction of slow-feeding component was less than a few percent. (auth)

17020 HIGH-SPIN STATES IN ^{155}Dy AND ^{154}Dy FROM (^{12}C, xn,γ) STUDIES. Krien, K. (Princeton Univ., NJ); Naumann, R. A.; Rasmussen, J. O.; Rezanka, I. Nucl. Phys.; A209: No. 3, 572-588(30 Jul 1973).

Levels in ^{155}Dy and ^{154}Dy were studied using $^{146}Nd(^{12}C,xn,\gamma)$ reactions. Excitation functions between 57 and 109 MeV, γ-angular distributions and γ-γ-time three dimensional coincidence relationships were determined. The most intense feature of the ^{155}Dy spectrum is a cascade of stretched E2 transitions between levels of the strongly mixed positive-parity band arising from the $i_{13/2}$, N = 6 shell-model state. Several of the strong γ-rays associated with a 6 μs isomer are also observed and placed in this decay scheme with this $^{11}/_2^-$ isomeric state of ^{155}Dy at 233.4 keV. A less strongly populated rotational band is based on this $^{11}/_2^-[505]$ orbital. The available information on ^{155}Dy from this and previous studies is discussed to arrive at a consistent interpretation. Coriolis mixing calculations are performed for the positive parity band and compared with the experimental data. Additional transitions of the ground rotational band in ^{154}Dy are identified up to the level with spin 14^+ (18^+). For the spins higher than 14 "back-bending" occurs. Transitions from states of a β-vibrational band are confirmed. (auth)

17021 CHANGE OF THE NUCLEAR CHARGE RADIUS IN EXCITATION OF 2^+ LEVELS IN YTTERBIUM ISOTOPES. Russell, P. B. (Stanford Univ., CA); Latshaw, G. L.; Hanna, S. S.; Kaindl, G. Nucl. Phys.; A210: No. 1, 133-156(1973).

Recoilless γ-ray spectroscopy was employed to study isomer shifts of $2^+ \longrightarrow 0^+$ rotational transitions in the ytterbium isotopes $^{170,172,174,176}Yb$. For ^{170}Yb conventional source experiments were performed, while for the other nuclei the method of recoil implantation through vacuum following Coulomb excitation was used to produce single-line Moessbauer sources. For ^{170}Yb isomer shifts were measured for a series of divalent, trivalent, and metallic single-line absorbers with mostly cubic symmetry. In addition, the effect of interference between resonant nuclear absorption followed by internal conversion and photoelectric absorption was observed. For the dispersion term a weighted mean of $2\xi = -0.030 \pm 0.004$ was derived. In the implantation experiments isomer shifts were measured between highly enriched absorbers of YbF_2 and Yb_2S_3. From the measured differences in isomer shifts the following ratios were derived: $\Delta\langle r^2\rangle_{172}/\Delta\langle r^2\rangle_{170} = 0.34 \pm 0.08$, $\Delta\langle r^2\rangle_{174}/\Delta\langle r^2\rangle_{170} = -0.37 \pm 0.07$, $\Delta\langle r^2\rangle_{176}/\Delta\langle r^2\rangle_{170} = -0.14 \pm 0.04$. For an electron density difference of $\Delta|\psi|^2 = 4.0 \pm 1.2 \times 10^{26}$ cm^{-3} between Yb^{3+} and Yb^{2+}, as derived from optical isotope shift data for Yb and Sm ions, the following absolute values of $\Delta\langle r^2\rangle$ were obtained: $\Delta\langle r^2\rangle_{170} = 1.20 \pm 0.40 \times 10^{-3}$ fm^2, $\Delta\langle r^2\rangle_{172} = 0.41 \pm 0.20 \times 10^{-3}$ fm^2, $\Delta\langle r^2\rangle_{174} = -0.44 \pm 0.19 \times 10^{-3}$ fm^2, $\Delta\langle r^2\rangle_{176} = -0.17 \pm 0.10 \times 10^{-3}$ fm^2. This marked dependence of $\Delta\langle r^2\rangle$ on the neutron number is especially striking in view of the constancy of nuclear deformation in this series of ytterbium isotopes, but it is in good agreement with the predictions of a recent microscopic theory of Meyer and Speth. (auth)

17022 β DECAY OF ^{168}HO TO LEVELS IN ^{168}Er. Tirsell, K. G.; Multhauf, L. G. (Lawrence Livermore Laboratory, University of California Livermore, California 94550). Phys. Rev. C 7: No. 5, 2108-2122 (May 1973).

The β decay of ^{168}Ho to levels in the strongly deformed ^{168}Er nucleus has been studied using Ge(Li) spectroscopy. Over 150 γ rays were observed, about half of which could be assigned to ^{168}Ho decay. Among the rotational bands that have been identified in ^{168}Er are the ground state, the γ band at 821.109 keV, and $K^\pi = 4^-$ and 3 bands at 1093.898 and 1541.33 keV, respectively. At higher energies, evidence was obtained for bands having energies ($I^\pi K$) of 1848.20 (2^+2), 1930.23 (2^+2), 2192.97 (2^-2), and 2424.87 (2^+2) keV. β–decay logft values to levels of ^{168}Er support a 3^+3 assignment for the ^{168}Ho ground state. (auth)

17023 MÖSSBAUER EFFECT FOLLOWING COULOMB EXCITATION OF THE 43.8–KEV STATE OF ^{161}DY. Sylvester, Steven C.; Schroeer, Dietrich (Department of Physics, University of North Carolina, Chapel Hill, North Carolina 27514). Phys. Rev. C 7: No. 5, 2056-2064 (May 1973).

The Mössbauer effect following Coulomb excitation of the 43.8–keV state of ^{161}Dy was studied for several Dy compounds and Dy metal. At 85 °K, using 3.3–MeV α particles, effects as large as 3.5% were observed; a scintillation counter gave typical counting rates of 2000 counts/sec; 43.8–keV γ rays made up about one third of the total count rate. The half–life of this state predicts $2\Gamma_o = 8$ mm/sec; the narrowest single line observed was 16 mm/sec. Dy–metal spectra taken at various temperatures were interpreted assuming a normal hyperfine interaction plus a central peak due to relaxation effects. The extracted value of the nuclear magnetic–dipole moment for this level of (-0.134 ± 0.005) μ_N agrees with the value calculated using the Nilsson model. The extracted value of the ratio of the intrinsic quadrupole moments of the ground and excited states of 1.12 ± 0.27 agrees with the value of 1.0 predicted by the Nilsson Model. The extracted difference in the nuclear radius for the ground and excited states is $\delta R/R = (-1.2 \pm 0.6) \times 10^{-5}$. A radiation–damage induced isomer shift corresponding to Dy^{4+} was observed in the DyF_3 target at liquid–nitrogen temperature. (auth)

17024 STUDY OF HAFNIUM α EMITTERS: NEW ISOTOPES ^{159}Hf, ^{160}Hf, AND ^{161}Hf. Toth, K. S.; Hahn, R. L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Bingham, C. R.; Ijaz, M. A.; Walker, R. F. Jr. Phys. Rev. C 7: No. 5, 2010-2018 (May 1973).

With the use of α spectroscopy and the helium gas–jet technique the α decay of the previously unknown isotopes, ^{159}Hf, ^{160}Hf, and ^{161}Hf, was observed. These hafnium nuclides were produced by bombarding targets of ^{144}Sm and ^{147}Sm with ^{20}Ne ions accelerated in the Oak Ridge isochronous cyclotron. The decay characteristics and mass assignments (made on the basis of yield curve measurements, cross bombardments, and parent–daughter relationships) of the three new α emitters are as follows: (1) ^{159}Hf, $E_\alpha = 5.09\pm0.01$ MeV, $T_{1/2} = 5.6\pm0.5$ sec; (2) ^{160}Hf, $E_\alpha = 4.77 \pm 0.02$ MeV, $T_{1/2} \approx 12$ sec; and (3) ^{161}Hf, $E_\alpha = 4.60\pm0.01$ MeV, $T_{1/2} = 17\pm2$ sec. The latter two isotopes with neutron numbers of 88 and 89 are of some interest with respect to α–decay systematics in the 82–neutron region. The only 88–neutron α emitters known up to now are naturally occurring ^{152}Gd and long–lived

^{154}Dy, while ^{161}Hf is the first 89-neutron nuclide to exhibit α decay. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 16753, 16865, 16955, 16966, 16992, 16994, 16999, 17008, 17014, 17017, 17055, 17088, 17103, and 17124.

17025 (BMFT-FBK-73-2, pp 65-69) COMPARISON OF SPECTROSCOPIC FACTORS FOR PROTONS AND NEUTRONS IN THE (^{138}Ba + p) AND (^{207}Pb + p) SYSTEMS. Steinmetz, B.; Stroemich, A.; von Brentano, P.; Berinde, A. Mar 1973. (In German).

17026 (UUIP-805) DECAY OF ^{190}Au. Johansson, A.; Nyman, B. (Uppsala Univ. (Sweden). Inst. of Physics). Feb 1973. 31p. Dep. NTIS (U. S. Sales Only) $3.75.

Internal conversion electrons, positrons and gamma-rays from the decay of ^{190}Au ($T_{1/2}$ = 42.8 ± 1.0 min) were studied using a 50 cm radius iron-yoke double focussing beta-ray spectrometer and a Ge(Li)-detector of 8% relative efficiency. On the basis of the measured K-conversion coefficients, multipolarities were deduced for the majority of the transitions. The Q-value of the ^{190}Au decay was determined to be 4442 ± 15 keV. The proposed decay scheme accommodates 49 transitions and tentative spin-parity assignments were given for all the suggested 17 levels. (auth)

17027 MAGNETIC MOMENT OF A CORE-EXCITED ISOMERIC STATE IN ^{210}Po. Yamazaki, Y.; Nagamiya, S.; Nomura, T.; Nakai, K.; Yamazaki, T. (Physical and Chemical Research, Wako-shi, Saitama-ken, JA). Phys. Lett.; 44B: No. 5, 440-442 (28 May 1973).

The g-factor of the core-excited isomeric 13^- state in ^{210}Po was determined to be +0.546 ± 0.012 with the time-differential spin-rotation method in the ^{208}Pb(α,2n)^{210}Po reaction. This value supports the configuration of $[(\pi h_{9/2}^2)8^+ \otimes 5^-(^{208}\text{Pb})]\ 13^-$. (auth)

17028 THE g-FACTOR OF THE $^{13}/_{2}^{+}$ STATE IN ^{207}Po AND THE MESONIC CONTRIBUTION TO THE MOMENT OF THE $i_{13/2}$-NEUTRON. Riegel, D.; Braeuer, N.; Focke, B.; Goldmann, A.; Hadijuana, M.; Hartrott, M. v.; Nishiyama, K. (Freie Univ., Berlin). Phys. Lett.; 44B: No. 5, 456-458(28 May 1973).

The magnetic moment of the $^{13}/_{2}^{+}$ state in ^{207}Po was determined to be $\mu = -0.910 \pm 0.014$ n.m. An analysis of this value and other known moments of $i_{13/2}$ neutron states around ^{208}Pb supports the existence of a mesonic contribution of at least −0.3 n.m. to the moment. (auth)

17029 HIGH SPIN ISOMER IN ^{204}Bi. Rakivnenko, Yu. N. (Physico-Tech. Inst. of the Ukranian Academy of Sciences, Kharkov); Klyucharev, A. P.; Lutsik, V. A.; Skakun, E. A.; Romaniy, I. A.; Kaun, K. H.; Neubert, W.; Schulze, W.; Stary, F.; Peker, L. K.; Volmyanski, E. I. Phys. Lett.; 44B: No. 5, 462-464(28 May 1973).

By making use of heavy-ion and α-particle induced reactions an isomeric state was found in ^{204}Bi, with a half-life of $T_{1/2}$ = 1.07 ± 0.03 ms and the quantum characteristics $I^{\pi} = 16^+$. The four-quasiparticle configuration $\nu(i_{13/2})^{-2}\nu(f_{5/2})^1\pi(h_{9/2})^1$ was ascribed to this state. (auth)

17030 EXPERIMENTAL DETERMINATION OF SOME MATRIX ELEMENTS OF THE EFFECTIVE RESIDUAL INTERACTION AMONG PARTICLE-HOLE CONFIGURATIONS IN ^{208}PB. Heusler, A. (Service de Physique Nucléaire à Basse Energie, Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France); von Brentano, P. Ann. Phys. (N.Y.) 75: No. 2, 381-404 (Feb 1973).

Matrix elements of the residual interaction in ^{208}Pb are derived from the wavefunctions and the energies of states and configurations in ^{208}Pb. From the experimentally determined wavefunctions of 20 low-lying states in ^{208}Pb with spins $I^{\pi} = 2^-, 3^-, 4^-, 5^-, 6^-, 7^-$ one obtains matrix elements of the effective residual interaction among particle-hole configurations defined with respect to the physical ground state of ^{208}Pb. The average value of these matrix elements is about 100 keV. No significant difference in the average value of the off-diagonal matrix elements is found for the different spin values. Also many nondiagonal matrix elements have values approaching the diagonal matrix elements. (auth)

17031 FISSION OF ^{209}Bi BY 36.1-MeV PROTONS: SEARCH FOR AN ASYMMETRIC COMPONENT IN THE MASS DISTRIBUTION, AND NEUTRON-EMISSION RESULTS. Plasil, Franz; Ferguson, Robert L.; Pleasonton, Frances; Schmitt, H. W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 3, 1186-1193 (Mar 1973).

A thin deposit of ^{209}Bi was bombarded with 36.1-MeV protons from Oak Ridge isochronous cyclotron and correlated energies of fission-fragment pairs were measured with silicon surface-barrier detectors. The mass-yield distribution obtained from these energies was compared with the radiochemical results of Sugihara, Roesner, and Meadows; we do not confirm the existence of the small asymmetric peak that appears in the wings of their distribution. Studies of statistical uncertainties and dispersion effects in our experiment indicate that they are not large enough to wash out such peaks. The average number of neutrons emitted as a function of fragment mass was obtained from a cumulative yield calculation and is consistent with an earlier measurement for ^{4}He-induced fission of ^{209}Bi. Pre-neutron-emission mass and kinetic energy distributions are presented. (auth)

17032 ANALYSIS OF MUONIC-ATOM X RAYS IN THE LEAD ISOTOPES. Ford, Kenneth W.; Rinker, George A. Jr. (Los Alamos Scientific Laboratory, University of California, Los Alamos New Mexico 87544). Phys. Rev. C 7: No. 3, 1206-1221 (Mar 1973).

We apply a radial-moment analysis to existing muonic-atom data for the nuclei ^{208}Pb, ^{207}Pb, ^{206}Pb, and ^{204}Pb, with emphasis on the directly measured isotope shifts and with special attention to charge-density functions of the forms that have been used to fit high-energy electron scattering data. The accuracy of the method is investigated and found to be sufficient for a detailed interpretation of the presently available data. When analyzed in terms of radial moments, the isotope shifts show clearly that the charge-density function must change significantly in shape (not merely in radial extent) in order to describe all of the isotopes. A like pair is formed by ^{208}Pb-^{207}Pb, which differ only in radial scale. A similar pair appears to be formed by ^{206}Pb-^{204}Pb. These last two isotopes have significantly less diffuse surfaces than ^{208}Pb and ^{207}Pb. We find, in agreement with other analyses, that, if the charge distribution is chosen to fit best those transitions which do not involve the 1s state, the resulting predicted binding of the 1s state is about 3 keV less in all four isotopes than is indicated by experiment. This difference is not experimentally significant, since it is possible to fit all transitions which are strongly affected by the charge distribution. Our analysis brings out a significant and still unexplained discrepancy between muonic-atom isotope shift measurements and electronic isotope shift measurements, the muonic shifts being typically larger by a factor of 1.5. (auth)

17033 NUCLEAR MAGNETIC RESONANCE OF ORIENTED ^{196}Au, ^{198}Au, AND ^{200m}Au. Bacon, F.; Kaindl, G.; Mahnke, H. -E.; Shirley, D. A. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 7: No. 4, 1654-1663 (Apr 1973).

Thermal equilibrium nuclear orientation was employed to orient nuclei of ^{196}Au, ^{198}Au, and ^{200m}Au as dilute impurities in nickel and iron at temperatures down to 4 mK. The degree of nuclear orientation was determined from the anisotropy of γ radiation emitted from the oriented nuclei. For ^{200m}AuNi both the magnetic hyperfine interaction $|\mu H| = (7.65 \pm 0.30) \times 10^{-18}$ erg and the magnetic hyperfine splitting $|\mu H/I| = (6.473 \pm 0.012) \times 10^{-19}$ erg were determined from an analysis of the temperature dependence of γ-ray anisotropies and by nuclear magnetic resonance on oriented nuclei (NMR/ON), respectively. As a result the spin I and the magnetic moment μ of the isomeric state could be derived as $I = 12^{(-)}$ and $\mu\ (12^-) = (\pm)\ (6.10 \pm 0.20)\ \mu_n$. From the measured anisotropies of five γ rays originating from the β^--decay of ^{200m}Au, spins and multipolarities could be assigned in the ^{200}Hg decay scheme. Nuclear magnetic resonance was also observed on oriented ^{196}Au and ^{198}Au in nickel at frequencies of 58.3 ± 0.4 MHz and 58.5 ± 0.4 MHz, respectively. The hyperfine interaction for Ni(^{197}Au), measured previously by spin echo, and our result for Ni(^{196,198}Au) agree with the known atomic hyperfine anomalies between ^{197}Au and ^{196,198}Au only if the hyperfine field is assumed to have a noncontact contribution. For Ni(^{196,198}Au) with $H_{hf} = (-)260.8 \pm 1.3$ kOe, the contact part is then found to be $H_c = -367 \pm 70$ kOe, with the noncontact contribution amounting to $H_{nc} = +106 \pm 70$ kOe. The angular distributions of several γ rays are in excellent agreement with a decay scheme proposed by Cunnane, et al., in which they found negative-parity levels of spins 5, 7, 9, and 11 at energies of 1852, 1963, 2144, and 2642 keV, respectively, in ^{200}Hg. (auth)

17034 MAGNETIC MULTIPOLE MOMENTS AND TRANSITION PROBABILITIES OF SINGLE-PARTICLE STATES AROUND ^{208}Pb. Bauer, R.; Speth, J.; Klemt, V.; Ring, P.; Werner, E.; Yamazaki, T. (Technische Univ., Munich). Nucl. Phys.; A209: No. 3, 535-556(30 Jul 1973).

Numerical calculations of magnetic dipole moments, magnetic octupole moments, M1, M2, M3 and M4 transition probabilities in odd-mass nuclei around ^{208}Pb are presented. The calculations are performed in the framework of the theory of finite Fermi systems with an effective magnetic operator. The dependence of the moments and transition probabilities on the effective operator and on the dimension of the configuration space is investigated. All theoretical results are in good agreement with the experimental values. (auth)

17035 RPA-CALCULATIONS IN ^{208}Pb WITH A DENSITY DEPENDENT INTERACTION. Ring, P. (Technische Univ., Munich); Speth, J. Phys. Lett.; 44B: No. 6, 477-480(11 Jun 1973).

Excitation energies and excitation probabilities of the low-lying states of ^{208}Pb are calculated within the theory of finite Fermi systems (FFS) by using a density-dependent residual interaction. A strong M2 transition at 7.51 MeV is predicted. (auth)

17036 STUDY OF THE REACTIONS ^{208}Pb(d,p) AND ^{208}Pb(d,t) NEAR THE COULOMB BARRIER. Vigdor, S. E.; Rathmell, R. D.; Liers, H. S.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A210: No. 1, 70-92(1973).

The vector analyzing power and differential cross section were measured at a deuteron energy of 12.3 MeV for ^{208}Pb(d,p) transitions to seven states of ^{209}Pb(E_x = 0.0, 0.79, 1.42, 1.56, 2.01, and 2.47 + 2.51 MeV), for ^{208}Pb(d,t) transitions to three states of ^{207}Pb (E_x = 0.0, 0.57, and 0.89 MeV), and for ^{208}Pb(d,d). Two deuteron optical model potentials were obtained from analysis of the elastic scattering measurements, and were used in a DWBA analysis of the present transfer-relation results and of previous results for ^{207}Pb(d,p_0)^{208}Pb. The sensitivity of the DWBA analysis to the nuclear interior is investigated. The relative importance of Coulomb and of nuclear distortions is discussed. The sign of the vector analyzing power for given l_n depends on j_n and on Q-value for both the (d,p) and the (d,t) reactions. The Q-dependence invalidates the simple rule proposed by Griffith and Roman to relate j_n to the predominant sign of iT_{11}. Comparison of the measurements and DWBA predictions for iT_{11} (θ) allows unambiguous determination of j_n for all transitions except ^{207}Pb(d,p_0). All spins determined confirm previous assignments. The vector analyzing powers for the ^{208}Pb(d,t_0)^{207}Pb and ^{207}Pb(d,p_0)^{208}Pb transitions are observed to be similar in angular dependence but opposite in sign at all angles. The sign reversal reflects differences in the distortions of the proton and triton waves. (auth)

17037 EVIDENCE FOR THE EXISTENCE OF ^{198}Ir. Szalay, A.; Uray, S. (Inst. of Nuclear Research, Debrecen, Hungary). Radiochem. Radioanal. Lett.; 14: No. 2, 135-143(15 Jun 1973).

Evidence was found for the existence of ^{198}Ir produced by bombarding an enriched ^{198}Pt target with 14-MeV neutrons. Its half-life, observed by means of a 407.76 ± 0.22 keV γ line belonging to the ^{198}Pt daughter nucleus, is 8 ± 3 s (max. error). The partial activation cross section of this transition amounts to 0.3 ± 0.1 mb. (2 figures) (auth)

17038 INELASTIC ELECTRON SCATTERING FORM FACTORS OF LOW-LYING STATES IN ^{208}Pb. Theis, W.; Werner, E. (Technische Univ., Hanover). Phys. Lett.; 44B: No. 6, 481-483 (11 Jun 1973).

Inelastic electron scattering form factors for some low-lying excited states of ^{208}Pb are calculated within the Migdal theory of interacting quasi-particles. The fairly good agreement with experiment is discussed. (auth)

17039 GIANT RESONANCES IN THE HIGH-ENERGY HELIUM INELASTIC SCATTERING. Lewis, M. B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 5, 2041-2043 (May 1973).

An analysis of earlier reported cross-section data from ^{208}Pb (α,α'), (^{3}He,^{3}He'), and ^{197}Au(^{3}He,^{3}He') reactions at E_α=90 MeV and $E_{^3He}$=75 MeV confirms the discovery of a new giant resonance at $E^* \simeq 11$ MeV in heavy nuclei. From the magnitude of the cross sections and theoretical sum-rule prescriptions, it is found that the resonance may be interpreted as a giant-quadrupole state but not, as recently suggested, a giant-monopole state. (auth)

17040 LIFETIME OF THE ^{197}Au MÖSSBAUER γ RAY. Lynch, Frank J. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 7: No. 5, 2160-2162 (May 1973).

Recently Potzel and Perlow reported that the linewidth obtained in Mössbauer measurements with AuCN and $KAu(CN)_2$ absorbers is anomalously narrow—only 80% of the value obtained with Au-metal absorbers or expected from the lifetime measurements by delayed coincidence. In an attempt to resolve this discrepancy, the lifetime has been remeasured with the Au source in two different chemical environments. The resulting half-lives were 1.93 ± 0.03 nsec for Au in Pt metal and 1.98 ± 0.06 nsec for Au in solution, in agreement with previous lifetime measurements and recent Mössbauer measurements with Au-metal absorbers. The anomaly remains unresolved. (auth)

17041 GAMMA DECAY OF EXCITED STATES IN ^{210}Bi AND AN INTERPRETATION WITH THE SHELL MODEL. Proetel, D.; Riess, F. (Sektion Physik der Universität München, Garching, Germany); Grosse, E.; Ley, R.; Maier, M. R.; (and others). Phys. Rev. C 7: No. 5, 2137-2150 (May 1973).

The γ decay of excited states in ^{210}Bi up to 3250-keV excitation energy has been studied with the ^{209}Bi(d,pγ) reaction at 8.0- and 10.0-MeV incident deuteron energies, using particle-γ and γ-γ coincidence techniques and a pulsed deuteron beam. For almost all of the states excited in this reaction, γ-decay branching ratios were obtained. The branched decay of states with a dominant configuration $(d^{\nu}_{5/2}\otimes h^{\pi}_{9/2})$ into states with a $(g^{\nu}_{9/2}\otimes h^{\pi}_{9/2})$ configuration was analyzed to determine experimentally the amount of configuration mixing between these two multiplets. The obtained mixing amplitudes are in remarkably good agreement with shell-model calculations. From the observed lifetimes of the $(g^{\nu}_{9/2}\otimes h^{\pi}_{9/2})_{5,7}$ states, a reduced matrix element of $\langle g^{\nu}_{9/2}||E2||g^{\nu}_{9/2}\rangle = -38\pm4$ e fm^2 has been extracted. This value is in good agreement with an intermediate coupling calculation which yields −35 e fm^2. (auth)

17042 INVESTIGATION OF THE ^{208}Pb(p,p′) REACTION AT E=54 MEV. Lewis, M. B.; Bertrand, F. E.; Fulmer, C. B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 5, 1966-1972 (May 1973).

Collective excitations of ^{208}Pb were investigated by inelastic proton scattering at 54 MeV. The spectra covered the entire bound-state region for scattering angles between 11 and 58°, and scattered particles were detected in a broad-range spectrograph with energy resolution ≃35-40 keV full width at half maximum. The experimental angular distributions were compared to those predicted by distorted-wave Born-approximation calculations, utilizing a collective-model form factor. The location of the low-spin members of a sequence (2^+-8^+) of positive-parity states was confirmed. Likely candidates for $J>8$ states were found, as well as several collective fragments of 3⁻ and 4^+ strengths. No appreciable fragmentation of the 2^+ strength was found. Energy-weighted sum-rule strengths were estimated for all multipoles studied and were compared with the measured values. (auth)

17043 PRECISION MAGNETIC MOMENT DETERMINATIONS FOR 43-MIN ^{199m}Hg AND OTHER ISOMERS OF MERCURY. Reimann, R. J.; McDermott, M. N. (University of Washington, Seattle, Washington 98195). Phys. Rev. C 7: No. 5, 2065-2079 (May 1973).

Optical pumping with the 2537 A intercombination line of mercury has been used to orient four nuclear spin I = 13/2 isomers of mercury and two I = 1/2 radioisotopes as well as stable I = 1/2 ^{199}Hg and I = 3/2 ^{201}Hg. Measurements of ratios of the nuclear-magnetic-resonance frequencies of these isotopes to that of ^{199}Hg contained in the same sample cell have been made. The results are tabulated. Independent measurements also give ν_{195m}/ν_{195} = 0.1484051(3) and ν_{197m}/ν_{197} = 0.1498984(3). Values of $A(^3P_1)$ are combined with the above ratios to give differential hyperfine-structure anomalies. Magnetic moments and hyperfine-structure anomalies are calculated by means of a nuclear configuration-mixing model and compared with the experimental results. (auth)

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Refer also to abstracts 16969, 16992, 16993, 16999, 17051, 17071, 17083, 17103, and 17109.

17044 (INDC(CCP)-32-U) NUCLEAR PHYSICS RESEARCH IN THE USSR. Collected Abstracts, Issue 13. (International Nuclear Data Committee). Apr 1973. 26p. Dep. NTIS (U. S. Sales Only) $3.50.

Sources for the thirteen abstracts included are preprints, journal articles, and papers presented at meetings. Although the subjects vary widely, the emphasis is on neutron reactions, particularly with heavy nuclei. (RWR)

17045 (LA-5172) EVALUATED NEUTRON-INDUCED CROSS SECTIONS FOR ^{239}Pu AND ^{240}Pu. Hunter, R. E.; Stewart, L.; Hirons, T. J. (Los Alamos Scientific Lab., N. Mex). Jun 1973. Contract W-7405-eng-36. 52p. Dep. NTIS $5.45.

The cross sections for neutron-induced reactions with ^{239}Pu and ^{240}Pu were evaluated for incident-neutron energies from about 100 keV to 20 MeV. Tabulated values are presented, and recommended curves are compared with the experimental data. These cross sections are merged with the ENDF/B-III evaluated curves from 10 to 100 keV. Below 10 keV, the ENDF/B-III files are recommended. The complete cross-section sets were tested by comparing calculated and measured values for a series of integral experiments. These integral results are presented and discussed. (53 figures, 10 tables) (auth)

17046 (RLO-1388-211) RELATIVE EXCITATIONS OF THE ^{237}Pu SHAPE ISOMERS. Vandenbosch, R.; Russo, P. A.; Sletten, G.; Mehta, M. (Washington Univ., Seattle). 1973. 14p. Dep. NTIS $3.00.

The excitation energy of the 1120-ns spontaneous fission isomer of ^{237}Pu was shown to be 0.30 ± 0.15 MeV above that of the 82-ns isomer. The half-life of the longer-lived isomer may,

therefore, be determined by its radiation width rather than by its direct width. (2 figures, 1 table) (auth)

17047 (RLO-1388-213) INFLUENCE OF THE DOUBLE BARRIER ON THE QUADRUPOLE ABSORPTION COMPONENT OF PHOTOFISSION. Vandenbosch, R. (Washington Univ., Seattle). 1973. 11p. Dep. NTIS $3.00.

The dominance of the quadrupole component is near-threshold photofission of ^{240}Pu and its near absence in ^{232}Th is shown to follow naturally from the properties of the double-humped fission barriers. (2 figures, 1 table) (auth)

17048 (UCRL-51370) EVALUATED NEUTRON REACTION DATA FOR URANIUM 235. Howerton, R. J.; MacGregor, M. H. (California Univ., Livermore. Lawrence Livermore Lab). 21 Mar 1973. Contract W-7405-eng-48. 28p. Dep. NTIS $4.00.

Methods used to obtain evaluated neutron interaction and photon production data for ^{235}U are described. (4 figures, 2 tables, 174 references) (auth)

17049 EXCITATION FUNCTIONS FOR SPALLATION PRODUCTS AND FISSION ISOMERS IN ^{237}Np(^{4}He,xn)$^{241-x}$Am. Fleury, Alain (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11790 and Centre d'Études Nucléaires de Bordeaux-Gradignan, Gradignan, France); Ruddy, F. H.; Namboodiri, M. N.; Alexander, John M. Phys. Rev. C 7: No. 3, 1231-1237 (Mar 1973).

Cross sections as a function of energy (19–46 MeV) have been measured for the following products from the reactions of ^{4}He with ^{237}Np: ^{237g}Am, ^{238g}Am, ^{238m}Am, ^{239g}Am, ^{239m}Am, ^{240g}Am. The prompt fission and total reaction cross sections have also been determined from 19 to 23 MeV. Isomer ratios as a function of excitation energy are presented for several fission isomers. (auth)

17050 PROMPT GAMMA RAYS FROM ^{235}U(n,f), ^{239}Pu(n,f), AND SPONTANEOUS FISSION OF ^{252}Cf. Verbinski, V. V.; Weber, Hans; Sund, R. E. Phys. Rev. C; 7: No. 3, 1173-1185 (Mar 1973).

The spectra of prompt γ rays from ^{235}U(n,f), ^{239}Pu(n,f), and ^{252}Cf(s.f.) emitted at 0–10 nsec after fission were measured with <4 nsec time resolution. A γ-ray spectrometer with a near-Gaussian response was used over the entire energy region, and the prompt neutrons from fission were positively rejected by time of flight. The measured γ-ray spectra show a systematic softening with increasing mass number for ^{235}U, ^{239}Pu, and ^{252}Cf. The average photon energy above 0.14 MeV is 0.97 ± 0.05, 0.94 ± 0.05, and 0.88 ± 0.04 MeV/photon for thermal-neutron fission of ^{235}U and ^{239}Pu, and spontaneous fission of ^{252}Cf, respectively. This behavior is discussed in terms of nearness of Z and N of the average fission fragement to closed-shell values, of the corresponding changes in level density expected, and of corroborative evidence from x-ray measurements. The total γ-ray energy released, $E_{\gamma,tot}$, is 6.51, 6.81, and 6.84 MeV/fission for ^{235}U(n,f), ^{239}Pu(n,f), and ^{252}Cf(s.f.), respectively, for photons above 0.14 MeV and for 0–10 nsec after fission. The calculations of Thomas and Grover are seen to be in agreement with these data in that they predict the correct partition of fission-fragment deexcitation energy between neutron and photon emission. This partition is related to the separation energy required to emit an additional neutron, to the pairing energy, and to the spin barrier for neutron emission. Two theoretical γ-ray spectra were compared to the measured spectrum for ^{235}U(n,f), and each was found to fit the measured spectrum well over only a limited portion of the total energy range. (auth)

17051 EXCITATION FUNCTIONS FOR THE FISSION ISOMERS ^{240m}Pu AND ^{239m}Pu FROM ^{238}U(^{4}He,xn) REACTIONS. Namboodiri, M. N.; Ruddy, F. H.; Alexander, John M. (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11790). Phys. Rev. C 7: No. 3, 1222-1230 (Mar 1973).

Excitation functions have been measured for the fission isomers ^{240m}Pu and ^{239m}Pu produced in the reactions of ^{238}U with ^{4}He. A value of 2.4 ± 0.5 nsec was obtained for the half-life of ^{240m}Pu. The high detection efficiency of thick targets and annular detector geometry has been used and refined. Upper limits of 0.3 and 0.6 μb have been obtained for the production of 29-nsec ^{240m}Pu and 6.5-nsec ^{238m}Pu, respectively. (auth)

17052 FRAGMENT-MASS RATIOS IN ^{252}Cf FISSION VERSUS PROMPT GAMMA-RAY ENERGY. Brooks, J. W. Jr.; Reines, F. (University of California, Irvine, California 92664). Phys. Rev. C 7: No. 4, 1579-1591 (Apr 1973).

γ-rays associated with the spontaneous fission of ^{252}Cf have been observed in the energy range 10–16 MeV using two 7.6-cm by 29.2-cm-diam. NaI(Tl) crystals in coincidence with two solid-state fission counters. Evidence is presented for a γ-ray multiplicity of 2 implying the presence of a collective mode of fragment deexcitation. The fission-fragment-mass-ratio distribution shows an increase in the number of symmetric fissions when the detected γ-energy exceeds 14 MeV. It is suggested that deexcitation of the fragments by the giant dipole resonance may be responsible for the presence of the high-energy γ-rays. (auth)

17053 HIGH-ENERGY GAMMA RAYS FROM SPONTANEOUS FISSION OF ^{238}U. Sobel, H. W.; Hruschka, A. A.; Kropp, W. R.; Lathrop, J.; Reines, F. (University of California, Irvine, California 92663); (and others). Phys. Rev. C 7: No. 4, 1564-1579 (Apr 1973).

A large shielded liquid-scintillation detector operating 3240 m below the surface of the earth was used to detect γ-rays from the spontaneous fission of a ^{238}U source. In an energy range from 8 to 20 MeV, the derived spectrum is: $N(E) = (6.99\pm0.60) \times 10^{1} e^{E/1.41\pm0.12}$ photons fission^{-1} MeV^{-1}. (auth)

17054 MEASUREMENT OF THE NUCLEAR RAMAN EFFECT. Hass, M.; Salzmann, D. (Weizmann Institute of Science, Rehovoth, Israel). Phys. Rev. C 7: No. 4, 1718-1719 (Apr 1973).

The parameters of the giant dipole resonance of ^{238}U are calculated from the experimental cross sections of the nuclear Raman effect. It is shown that there is no need to include direct mechanisms to explain the interaction of the γ with the nucleus. (auth)

17055 ATOMIC MASSES OF ^{232}Th, U^{235}, AND U^{238} AND A MASS TABLE FOR THE HEAVY ISOTOPES. Britten, Rodney A.; Johnson, Walter H. Jr. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). Phys. Rev. C 7: No. 4, 1545-1555 (Apr 1973).

This paper reports the results of the authors' mass spectroscopic measurements on the masses of the isotopes ^{232}Th, ^{235}U, and ^{238}U. Notice is taken of recently reported mass-difference measurements and Q-value measurements, and a least-squares process is used to construct a new mass table for the heavy isotopes. This table differs from Wapstra's 1967 table in two major respects: (1) For most isotopes with $A>220$ the new mass value is lower than the old mass value by 20–25 μu, or roughly 11/2 times the quoted error in the 1967 table. (2) As a result of the new measurements, the uncertainty in our knowledge of the masses of most of the heavy isotopes has been reduced by very roughly a factor of 3. (auth)

17056 MEASUREMENT OF DELAYED NEUTRON SPECTRA FROM THERMAL FISSION. Sloan, W. R. Seattle; Univ. of Washington (1973). 153p. University Microfilms Order No. 73-13,880.

Thesis (Ph.D.).

The delayed-neutron spectral data reported are for thermal-neutron fission of ^{233}U, ^{235}U, and ^{239}Pu. These data were obtained by proton-recoil measurements of cyclical irradiations of each isotope with three different irradiation cycles. A high-resolution (<10% at 700 keV) proton-recoil system was built to obtain the delayed-neutron spectra. This system incorporated gamma discrimination. The complete counting system developed incorporates state-of-the-art capabilities of electronic components as applied to proton recoil spectrometers. Computation of neutron spectra from proton-recoil spectra was done by using the PSNS code. A digital filtering technique based on the Fast Fourier Transform (FFT) was developed to improve the statistical properties of the data. The delayed-neutron spectra reveal complex spectra with a number of well-defined peaks. This structure indicates that preferred transitions exist for delayed neutron emission. The data also indicate a somewhat softer equilibrium spectrum for ^{235}U than previously reported. (RWR)

17057 CHARGE DISPERSION AND RECOIL PROPERTIES AT A=131 FROM THE INTERACTION OF ^{238}U WITH 11.5 GEV PROTONS. Yu, Yu-Wen; Porile, N. T. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). Phys. Rev. C 7: No. 4, 1597-1610 (Apr 1973).

Independent and cumulative yields have been measured for eight A=131 nuclides formed in the interaction of ^{238}U with 11.5-GeV protons. A good fit to the cross sections was obtained with a charge dispersion consisting of two overlapping Gaussians peaking at Z=52.2 and 56.5. The neutron-excessive curve accounts for about 40% of the total isobaric yield of 23.3 ± 0.4 mb. Thick-target recoil properties were determined for all the nuclides. The recoil ranges are characteristic of fission fragments for ^{131}Sb through ^{131}Cs but decrease by a factor of 2 between ^{131}Cs and ^{131}La. This decrease occurs some two Z units beyond the minimum between the two humps in the charge dispersion. The deposition energies derived from the recoil data exhibit a similar trend as the ranges, increasing in the manner expected for fission products up to barium but not beyond. The transformation of isotopic to isobaric yield distributions is considered and it is concluded that the use of N/Z as the composition variable gives the best agreement with experiment. (auth)

17058 PAIR PRODUCTION IN ALPHA DECAY. Ljubičić, A.; Logan, B. A. (University of Ottawa-Carleton University, Nuclear Physics Group, Physics Department, University of Ottawa, Ottawa, Ontario, Canada.). Phys. Rev. C 7: No. 4, 1541-1545 (Apr 1973).

Electron–positron pairs have been observed in the α decay of

^{241}Am. A result of $(3.1 \pm 0.6) \times 10^{-9}$ pairs per α decay was obtained. It is believed that the pairs are due to internal pair production occurring in the α-decay process. An approximate calculation, which assumes this production mechanism, is in reasonable agreement with the experimental result. (auth)

17059 DECAY OF ^{235}PU. Jäger, U.; Münzel, H.; Pfennig, G. (Institute for Radiochemistry, Kernforschungszentrum Karlsruhe, 75 Karlsruhe, Postfach 3640, Germany). Phys. Rev. C 7: No. 4, 1627-1631 (Apr 1973).

^{235}Pu was produced by the bombardment of ^{233}U with 30-MeV α particles, and its decay was studied by γ-ray spectroscopy after a chemical separation. This isotope decays predominantly by electron capture with a half-life of 25.6 min. Energies and intensities of 15 γ rays have been determined. An extended decay scheme is proposed and electron-capture EC-branching intensities are given. (auth)

17060 MAIN COMPONENTS DETERMINATION BY THE METHOD OF DELAYED NEUTRONS IN THE FISSION OF URANIUM-235 BY THERMAL NEUTRONS. Schuessler, H. D.; Herrmann, G. (Univ., Mainz). Radiochim. Acta; 18: No. 3, 123-133(1972). (In German).

Rapid radiochemical separation methods were used to determine the main components of the delayed-neutron precursors in fission of ^{235}U by thermal neutrons. The contributions of bromine and iodine isotopes and the total contribution of the nonhalogen elements were determined, as well as the contributions of individual nonhalogen elements like rubidium, cesium, and yttrium. A new delayed-neutron precursor, 0.8-sec ^{140}I, was identified and another one, 1.1-sec $^{98,99}Y$, was confirmed. By normalizing relative abundances of delayed-neutron precursors via the yield of the 22-sec neutron group, the neutron yields of the precursors in the fission process studied were obtained; their neutron emission probabilities were derived by comparing neutron yields with fission yields. Summing-up the neutron yields of all known precursors within each group results within the error limits in total yields equal to the group yields. (6 figures, 7 tables) (auth)

17061 SEARCH FOR SUPERHEAVY ELEMENTS IN URANIUM IRRADIATED WITH HIGH-ENERGY PROTONS. Brandt, R.; Molzahn, D.; Patzelt, P. (Univ., Marburg, Ger.). Radiochim. Acta; 18: No. 3, 157-158(1972).

Liquid samples derived from the beam stop of the CERN proton synchrotron were examined. Chemical separations were carried out, and counting was done by using a semiconductor fission fragment spectrometer, a proportional (CH_4-flow) counter, and a mica plate. No spontaneous fission activity due to the decay of superheavy elements was detected. An upper cross section limit of 10^{-39} to 10^{-40} cm^2 was estimated for the production of a superheavy element having a half-life of 60 days. (1 table) (RWR)

17062 SUPERHEAVY ELEMENTS FROM R-PROCESS CALCULATIONS WITH AN ENERGY-DENSITY MASS FORMULA. Brueckner, K. A.; Chirico, J. H.; Jorna, S.; Meldner, H. W. (Institute for Pure and Applied Physical Sciences and Department of Physics, University of California at San Diego, La Jolla, California 92037); Schramm, D. N.; (and others). Phys. Rev. C 7: No. 5, 2123-2128 (May 1973).

Astrophysical superheavy-element synthesis by rapid neutron capture is studied by utilizing nuclear masses from energy-density functional calculations and a new β-decay formula in a modified r-process code. We find reduced abundances for elements with large atomic numbers relative to those predicted by conventional mass formulas. Calculations have been performed with fission barriers corresponding to both large and small values of the surface-symmetry contribution to the deformation energy. Our results, based on a different mass-formula parametrization, show that it is possible to synthesize superheavy elements in the r process even for very large surface-symmetry corrections if certain mass-formula terms are modified. Also, a more realistic formula for β-decay rates yields r-process fission-cycle times which are about 1 order of magnitude shorter than previous values. (auth)

17063 MULTILEVEL ANALYSES OF THE ^{235}U FISSION AND CAPTURE CROSS SECTIONS. de Saussure, G.; Perez, R. B.; Kolar, W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Rev. C 7: No. 5, 2018-2032 (May 1973).

The neutron capture and fission cross sections of ^{235}U were analyzed up to 60 eV with the multilevel formalism of Reich and Moore. The statistical distribution of the R-matrix parameters obtained in this analysis has been investigated in detail. After corrections for the "missed levels," the observed statistical distributions of the parameters and level spacings agree well with the expected Porter-Thomas distributions and Wigner law, respectively. The average values of the resonance parameters do not agree for the same cross sections with the values obtained by other authors on the basis of the single-level formalism. The R-matrix parameters obtained in this analysis have been transformed into equivalent Kapur-Peierls parameters and compared with a set of Kapur-Peierls parameters obtained directly, from the same data, in a previous analysis. The comparison of the two sets of Kapur-Peierls parameters illustrates the nonuniqueness of the least-squares fit analysis of the same data with the Kapur-Peierls formalism. The set of resonance parameters obtained in this work has also been used to compute the fission cross section at liquid nitrogen temperature, for comparison with existing measurements, and to "mock-up" the cross sections in the unresolved resonance region near 1 keV, where S-wave processes still dominate. (auth)

17064 ISOMERIC STATES IN ^{250}Fm AND ^{254}No. Ghiorso, Albert; Eskola, Kari; Eskola, Pirkko; Nurmia, Matti (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 7: No. 5, 2032-2036 (May 1973).

A preliminary report on the discovery of isomeric states in ^{250}Fm and ^{254}No was included in a recent article on α-emitting isotopes of element 104. The existence and assignments of the 1.8 ± 0.1-sec isomer to ^{250}Fm and the 0.28 ± 0.04-sec isomer to ^{254}No have now been confirmed by cross-bombardment techniques. Isomeric ratios based on measurements of collection efficiency of recoil atoms from the decay of isomeric states are given. An interpretation of the even-even isomers as high-spin two-quasiparticle states is discussed. (auth)

17065 PARAMETERS OF THE SUBTHRESHOLD FISSION STRUCTURE IN ^{242}Pu. Auchampaugh, George F. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544); Bowman, C. D. Phys. Rev. C 7: No. 5, 2085-2091 (May 1973).

The neutron total cross section of ^{242}Pu has been measured from 600 eV to 81 keV using the new Lawrence Livermore Laboratory Linac. Parameters were obtained for those resonances below 4 keV with significant fission strengths. These parameters were used to study the fission widths of the intermediate structure in $^{242}Pu + n$ and the coupling matrix elements between the levels in the primary and intermediate wells in the double-humped fission potential barrier. The results show that the coupling in $^{242}Pu + n$ is very weak; the magnitude of the average coupling matrix element is less than 0.5 the level spacing in the primary well. The distribution of the fission widths of the levels in the primary well about their expected values is found to be consistent with a Porter-Thomas distribution. However, the distribution of the square of the coupling matrix element appears to require more than one degree of freedom, apparently implying two independent and equally accessible routes across the inner barrier to the deformed configuration. The Wigner distribution is shown to adequately describe the spacings between levels in the intermediate well. These measurements, taken together with Lynn's theory, suggest that fission from the 2741-eV resonance is primarily through the isomeric state. If verified experimentally, this would mean about a 10^4 increase in probability for isomeric fission compared to that induced by other means. (auth)

Nuclear Theory

Refer also to abstracts 16225, 16226, 16375, 16587, 16758, 16808, 16809, 16856, and 17008.

17066 (BMFT-FBK-73-2, pp 17-21) QUASI-FREE SCATTERING AND IMPULSE APPROXIMATION. Helten, H. J. Mar 1973. (In German).

17067 (COO-3235-24) ISOSPIN IN THE GIANT RESONANCE. Fallieros, S. (Brown Univ., Providence, R. I. Dept. of Physics). 1973. Contract AT(11-1)-3235. 6p. (CONF-730301-10). Dep. NTIS $3.00.

From international conference on photonuclear reactions and applications; Pacific Grove, California, USA (26 Mar 1973).

Some properties of excitations, mainly of isovector character, are reviewed. Although other multipolarities are considered, more detailed results are presented for E1 transitions. Total transition strengths and average excitation energies are discussed and are separated into contributions associated with the excitation of states of definite isospin. (auth)

17068 (FEI-252) DENSITY OF NUCLEAR LEVELS CORRESPONDING TO COLLECTIVE EXCITATIONS. Budnik, A. P.; Robotnov, N. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko Energeticheskii Institut). 1971. 10p. (In Russian). INIS.

The density of nuclear levels which corresponded to collective excitations of a surface oscillation type was calculated for the first three multipole orders as a function of the principal quantum number and angular momentum. The calculated density was an exponential function of the energy. The dependence on the momentum was approximately the same as for the single-particle density. The results of the calculation are discussed in connection with the possibility of the existence of collective excited states in the

second minimum of a deformation potential, manifest in the form of strong fission resonances during sub-barrier fission. (tr-auth)

17069 (FEI-270) GENETIC CONNECTION OF DELAYED NEUTRONS AND FISSION PROCESS. Maksyutenko, B. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 24p. (In Russian). INIS.

The genetic connection of delayed neutron emission and the fission process was examined. A method was developed for calculating the number of prompt neutrons from fission and its distribution with precision, by using data on the relative yields of delayed neutrons in the fission of ^{235}U by thermal neutrons. This method was applicable to similar calculations involving fast neutrons. The relationship between the number of prompt neutrons emitted and fragment mass was derived from a study of the charges and cumulative yields of the fission products. The width of the excitation energy distribution in fission was found. (11 figures) (tr-auth)

17070 (FEI-287) PHOTOABSORPTION CROSS SECTION IN THE NEUTRON THRESHOLD REGION AND AVERAGE RADIATIVE CAPTURE WIDTHS. Tertychnii, G. Ya.; Niledvin, S. D.; Yadrovskii, E. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko Energeticheskii Institut). 1971. 13p. (In Russian). INIS.

On the basis of shell calculations for $J^{\pi} = 1^-$ states in the nuclei ^{40}Ca, ^{90}Zr, ^{208}Pb, and the even isotopes of Sn, an analysis was made of the experimental data on the photoabsorption cross sections in the vicinity of the neutron threshold. The influence of the near-threshold maxima in the photoabsorption cross section on the average radiative widths and the forms of the γ spectra was considered for the neutron radiative capture reaction. (5 figures) (tr-auth)

17071 (FEI-316) CALCULATION OF FISSION FRAGMENT KINETIC ENERGY IN THE NUCLEAR DROP MODEL. Stavinskii, V. S.; Svin'in, I. R.; Seregin, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 9p. (In Russian). INIS.

Calculations were made of the kinetic energies of fission fragments for certain assumptions as to the fragmentation pattern in the liquid-drop model. The distance between fragments at the moment of scission was coupled to the pre-scission configuration. A comparison was made between the results obtained and the available experimental data on the ^{236}U nucleus, and the latter fitted the kinetic energies as calculated. (3 figures) (tr-auth)

17072 (IAE-2080) CRITICAL REVIEW OF PHENOMENOLOGICAL COLLECTIVE MODELS OF A NUCLEUS. Grechukhin, D. P. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 60p. (In Russian). INIS.

A systematic survey of the experimental data and fluid models of collective excitations of atomic nuclei was presented during a course of lectures given at the All-Union School of Nuclear Physics at Uzhgorod, 1969. The purpose of the survey was the elucidation of the problems of phenomenological models of quadrupole excitations of nuclei, and an evaluation of the accuracy of the fundamental postulates from which stem the desired variants of such models. Only collective quadrupole excitations of even nuclei were considered. This survey may be broadened later to include odd nuclei and other variants of nuclear models with collective excitations. (tr-auth)

17073 (KFTI-71-26) PHOTONUCLEAR REACTION CROSS-SECTION CALCULATIONS. Kuz'menko, V. S.; Ranyuk, Yu. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko Tekhnicheskii Institut). 1971. 12p. (In Russian). INIS.

Existing methods for calculating photonuclear reaction yields were analyzed, and two new programs were advanced for the calculation of cross sections from yield data. The programs were written in Algol-60 for the M-220 computer; one program ("Utyug-1") was a modified version of the Cook method of minimum structure. The chief difference was that of the smoothing criterion; in place of $x^2 = N$, the authors used the criterion $Q = N/2$, where Q is the number of intersections of the yield curve with the broken line joining the successive N original yield points. The second program ("Utyug-2") gave a solution in the form of a linear combination of appropriate functions (the Ivanchenko method) with a subsequent smoothing solution according to the x^2 or the Q criterion. Examples of the calculations are given. (10 figures) (tr-INIS)

17074 (LBL-1678) SOME NEW DEVELOPMENTS IN DIRECT REACTIONS INDUCED BY HEAVY IONS. von Oertzen, W. (California Univ., Berkeley. Lawrence Berkeley Lab). Apr 1973. Contract W-7405-eng-48. 42p. (CONF-730450-1). Dep. NTIS $4.25.

Reactions induced by heavy ions have been extensively studied in recent times (see, for example, the recent topical conferences). Specifically, direct reactions induced by heavy ions, like elastic and inelastic scattering and transfer reactions, rely on rather complicated experimental techniques for particle identification and methods of theoretical analysis. There has recently been considerable progress in both experimental techniques and in the understanding of the reaction mechanisms. At the present stage nuclear structure studies with direct reactions induced by heavy ions should indeed yield the information people believed should be obtainable. The situation is, however, by no means clear in all respects, and there is considerable work to be done on the new improved accelerators to establish the heavy-ion reactions as the specific spectroscopic tool they are expected to be. A few new experimental techniques are first briefly discussed, then some rather specific examples of heavy-ion reactions which show their unique possibilities are given, and finally some new concepts which were developed for the understanding of the transfer reactions are discussed. (20 figures) (auth)

17075 (NP-19803) EFFECT OF THE $\Delta(1236)$ IN NUCLEAR MATTER. Green, A. M.; Dahlblom, T. K.; Kouki, T. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1972. 23p. Dep. NTIS (U. S. Sales Only) $3.25.

The three main corrections to the binding energy of nuclear matter that involve the $\Delta(1236)$ are calculated with exchange effects and realistic correlation functions. It is found that their net effect at $k_F = 1.36$ fm^{-1} is small, but that their k_F-dependence has a considerable effect on the saturation density. (auth)

17076 (ORNL-tr-2652) APPROXIMATE METHOD OF CALCULATING THE INTERACTION OF FAST IONS WITH NUCLEI. Barashenkov, V. C.; Gavrilov, E. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated from JINR-P2-6423. 5p. Dep. NTIS $3.00.

The Glauber-theory formulas for collisions of two nuclei are expressed in terms of the amplitude of the nucleon-nucleus interaction. Such an approach is applicable to the description of collisions between nuclei differing considerably in their nuclear dimensions in the energy range >200 to 300 MeV/nucl of the incident nucleus. The paths of fast α particles in a photoemulsion are calculated. (1 figure) (auth)

17077 CONSTRAINTS IN WAVE MECHANICS AND INDUCED ROTATION IN NUCLEAR SCATTERING. Seglie, Ernest; Inglis, D. R. (University of Massachusetts, Amherst, Massachusetts 01002). Phys. Rev. D 7: No. 6, 1712-1719 (15 Mar 1973).

As an illustration of the problem of handling classical constraints in wave mechanics, the correct wave equation is obtained for a model consisting of two particles, one of them constrained to have a fixed radial distance from the origin and the other free save for an angular constraint confining the two radius vectors to be coincident. The particle with fixed radius is here equivalent to a thin rigid rod. The wave equation is obtained by starting with a system of two unconstrained particles in which the constraints are replaced by restoring forces, writing the wave equation in appropriate polar coordinates by transforming the Laplacian from Cartesian coordinates, and then going to the limit of strong restoring forces. If, in this problem of a rotating rigid rod collinear with the position of an otherwise free particle, one follows the rather usual procedure of using the derivative with respect the conjugate angular coordinate as the operator for a canonical angular momentum, one obtains in the radial wave equation in good approximation a "centrifugal potential" term with the familiar coefficient $l(l+1)$. The limiting procedure shows that the correct result instead has a similar term but with coefficient $l(l+1)+1$. Also the relation between the wave function and the solution of the radial equation is not the same as for a single particle. It is thereby shown that an application sometimes made to angular coordinates of a metric transformation in analogy to one from Cartesian to curvilinear coordinates is not strictly correct. The result derived by limiting procedure is related to recent discussion of ^{16}O-^{16}O scattering. (auth)

17078 PHOTOPRODUCTIONS OF VECTOR MESONS FROM COMPLEX NUCLEI. Egusa, T. (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto); 49: No. 1, 206-215 (Jan 1973).

Photoproductions of vector mesons from complex nuclei are reanalyzed by the simple nuclear model. Coherent and incoherent productions are evaluated by use of the strong interaction nuclear radii. Photon-vector meson coupling constants γ_ρ, γ_ω, γ_φ are also investigated. (auth)

17079 A SOLUBLE SELF-CONSISTENT NUCLEAR MODEL. de Llano, M. (Institutö de Física, Universidad de México, México 20, D.F.). Am. J. Phys. 41: No. 4, 484-489 (Apr 1973).

The self-consistent, independent-particle Hartree equations for N fermions interacting with a separable (in configuration space) two-body

potential are solved exactly in one and three dimensions. The exclusion principle is accounted for by allowing only one particle per orbital state. The possibility of only a finite number of particles being bound self-consistently, for given two-body force parameters, is studied and the effect of introducing the observed (in real nuclei) approximate constancy with particle number of particle density and common well depth is also considered. (auth)

17080 RIGOROUS SOLUTIONS FOR THREE-BODY REARRANGEMENT REACTIONS AND VALIDITY OF THE DISTORTED-WAVE BORN APPROXIMATION. Gambhir, Brij L. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627); Griffin, James J. Phys. Rev. C 7: No. 3, 1006-1009 (Mar 1973).

In a distorted-wave type of formalism, two well-behaved integral equations have been obtained for a general three-body rearrangement reaction. The inhomogeneous terms of these equations may be considered to provide mathematically meaningful first approximations (MMFA) to the reaction amplitude. In each of the above mentioned cases, the distorted-wave Born approximation (DWBA) forms an integral part of MMFA. The extra terms in MMFA involve multiple-scattering processes and hence, at least in some cases, their matrix elements may be much smaller than those of DWBA term. This suggests that the success of DWBA may lie in the fact that DWBA is the dominating part of an MMFA. Some of the circumstances under which it can happen are discussed. (auth)

17081 EFFECTIVE INTERACTION IN NUCLEI. Joshi, K. P.; Waghmare, Y. R. (Department of Physics, Indian Institute of Technology, Kanpur, India). Phys. Rev. C 7: No. 3, 874-881 (Mar 1973).

An equivalent potential is derived by best fitting the Sussex matrix elements. The derived equivalent potential is compared with the equivalent Yale potential obtained in a similar manner and with central effective potentials in widespread current use. Remarks are made about the general nature of the effective nuclear force. (auth)

17082 A PRACTICAL APPROACH TO THE CONTINUUM SHELL MODEL. Philpott, R. J. (Department of Physics, The Florida State University, Tallahassee, Florida 32306). Phys. Rev. C 7: No. 3, 869-874 (Mar 1973).

A second quantized version of the Lane-Robson reaction formalism is applied to the continuum shell-model problem. The dynamical equations have a matrix structure which differs from that encountered in the conventional shell model only through the addition of a relatively small number of states and the presence of complex, energy-dependent boundary-condition parameters. Oscillator basis states may be used throughout. All matrix elements may be evaluated by existing shell-model codes. The equations provide a practical basis for dynamical studies of resonance phenomena in single-nucleon scattering channels. An extension of the model to include cluster channels is suggested. (auth)

17083 ASTROPHYSICAL β-DECAY FORMULAS AND SUPERHEAVY ELEMENTS. Senbetu, Legesse (Institute for Pure & Applied Physical Sciences and Department of Physics, University of California at San Diego, La Jolla, California 92037). Phys. Rev. C 7: No. 3, 1254-1256 (Mar 1973).

We comment on currently used β-decay formulas in astrophysical and superheavy-element applications. A new formula of comparable simplicity but significantly improved accuracy is presented which predicts β-decay rates that increase more strongly with energy than do conventional extrapolations in the neutron-rich superheavy-element region. (auth)

17084 CENTER-OF-MASS MOTION IN MANY-PARTICLE SYSTEMS. Ernst, D. J.; Shakin, C. M.; Thaler, R. M. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 7: No. 3, 925-930 (Mar 1973).

We have reexamined the problem of constructing a nuclear ground-state wave function consistent with the requirement of translational invariance, beginning with a wave function which does not have this property. A class of transformations is constructed which transforms the initial-state vector into an eigenstate of total momentum. The particular transformation of this class which leads to the lowest intrinsic energy is given. (auth)

17085 SPIN AND SPIN-ISOSPIN SYMMETRY ENERGY OF NUCLEAR MATTER. Dabrowski, J. (Institute for Nuclear Research, Warsaw, Poland); Haensel, P. Phys. Rev. C 7: No. 3, 916-925 (Mar 1973).

The expression, $E/A=\epsilon_{vol}+(1/2)\epsilon_\tau\alpha_\tau^2+(1/2)\epsilon_\sigma\times(\alpha_n+\alpha_p)^2+(1/2)\epsilon_{\sigma\tau}(\alpha_n-\alpha_p)^2$, for the ground-state energy of nuclear matter with an excess of neutrons, of spin-up neutrons, and of spin-up protons (characterized by the corresponding parameters, $\alpha_\tau=(N-Z)/A$, $\alpha_n=(N\uparrow-N\downarrow)/A$ and $\alpha_p=(Z\uparrow-Z\downarrow)/A$, contains three symmetry energies: the isospin symmetry energy ϵ_τ, the spin symmetry energy ϵ_σ, and the spin-isospin symmetry energy $\epsilon_{\sigma\tau}$. Gerneral expressions for ϵ_σ and $\epsilon_{\sigma\tau}$ are obtained in terms of the K matrix which depends on four different Fermi momenta. With suitable approximations, numerical values of ϵ_σ and $\epsilon_{\sigma\tau}$ (and also of ϵ_τ) are derived using the Brueckner-Gammel-Thaler, the Hamada-Johnston, and the Reid soft-core nucleon-nucleon potentials. The most reliable results, obtained with the Reid soft-core potential, are $\epsilon_\tau=61$ MeV, $\epsilon_\sigma=74$ MeV, $\epsilon_{\sigma\tau}=73$ MeV. The possibility of estimating the energies of the spin and spin-isospin modes of collective nuclear excitations is discussed. (auth)

17086 RENORMALIZATION OF THE AXIAL-VECTOR COUPLING CONSTANT IN NUCLEAR β DECAY. Wilkinson, D. H. (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 7: No. 3, 930-936 (Mar 1973).

The isoscalar magnetic moments and Gamow-Teller β decay of the systems A=11, 13, 15, 17, 19, and 21 are analyzed in an attempt to extract, in a largely model-independent way, the effective nuclear renormalization of the axial coupling constant: $g_A - g_{Ae}$. We find: $g_{Ae}/g_A=0.920\pm0.047$. (auth)

17087 THRESHOLDS AND RESONANCES IN A THREE-BODY MODEL. Lovas, I. (Institut für Kernphysik, Kernforschungsanlage, Jülich, Germany); Dénes, E. Phys. Rev. C 7: No. 3, 937-942 (Mar 1973).

An exactly soluble three-body model is constructed which consists of two light particles and an infinitely heavy one having internal degrees of freedom. This model is designed to simulate various phenomena associated with isobaric-analog states, showing up in scattering and transfer reactions. The formulation and solution are done in the framework of Faddeev's theory using nonlocal separable potentials. The cross sections are calculated in the neighborhood of the channel thresholds. The effect of a resonance on the threshold is studied in detail and threshold anomalies are searched. (auth)

17088 HIGHER-ORDER CORRECTIONS TO BRUECKNER-HARTREE-FOCK BINDING ENERGIES AND RADII. Davies, K. T. R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); McCarthy, R. J.; Sauer, P. U. Phys. Rev. C 7: No. 3, 943-951 (Mar 1973).

Some higher-order corrections to renormalized Brueckner-Hartree-Fock calculations are estimated for the nuclei ^{16}O, ^{40}Ca, and ^{208}Pb. The diagrams of interest are the potential insertions in particle lines and the two-body correlation corrections to the rms radii. Studies are made of the sensitivity of these corrections to the shift in the intermediate spectrum used to calculate the G matrix. The correlation corrections to the radii are small and seem to increase somewhat as the intermediate spectrum is lowered, but there is no appreciable change in the over-all saturation properties. The errors involved in estimating the corrections are discussed. "Off-diagonal occupation probabilities" are also calculated and found to be small, thereby justifying ignoring such diagrams as is usually done in renormalized Brueckner calculations. (auth)

17089 COUPLED-REACTION-CHANNELS STUDY OF (h,t) REACTIONS. Coker, W. R.; Udagawa, T.; Wolter, H. H. (Center for Nuclear Studies, University of Texas, Austin, Texas 78712). Phys. Rev. C 7: No. 3, 1154-1165 (Mar 1973).

We have developed a formulation of the theory of multichannel nuclear reactions which permits practical and realistic numerical calculations in which a number of different reaction channels are coupled, assuming a zero-range approximation for the effective coupling and neglecting effects arising from the non-orthogonality of different reaction channels. A computer program, JUPITER-4, has been written embodying this coupled-reaction-channel formulation; and, as a specific application, we present analyses of the $(h,\alpha)-(\alpha,t)$ or pickup-stripping contributions to (h,t) reactions, for the specific cases of $^{48}Ca(h,t)^{48}Sc$ and $^{40}Ar(h,t)^{40}K$. We pay particular attention to the interplay and interference of direct and pickup-stripping amplitudes, and try to identify general tendencies. Finally, we give simple sum rules which aid in predicting the nature of the interference for specific spins of intermediate and final nuclear states. (auth)

17090 MICROSCOPIC THEORY OF NUCLEAR COLLECTIVE MOTION. Haff, P. K.; Wilets, L. (Physics Department, University of Washington, Seattle, Washington 98195). Phys. Rev. C 7: No. 3, 951-968 (Mar 1973).

A generalization of the Hill-Wheeler generator coordinate method is applied to collective deformations. The intrinsic wave function is constrained (as in constrained Hartree-Fock) to be characterized not only by a given deformation, but also by a deformation velocity. This is effected by a simple ansatz which involves operation on the singly constrained wave function by an exponential single-particle deformation operator containing an arbitrary function $\beta(\alpha)$, where α is the collective variable. The expectation value of the energy is minimized with respect to both $\beta(\alpha)$ and the Hill-Wheeler projection function $f(\alpha)$. This leads to an integral equation for f which, upon invoking the collective nature of the intrinsic states, may be approximated by a second-order differential equation in the deformation coordinate $\alpha=\langle Q\rangle$. In order to reduce this equation to the Schrödinger form, certain assumptions are introduced with regard to the approximate form of f. This procedure leads to two different differential equations for f

and to two mass parameters. One is valid in the classical region and one, in the classically inaccessible tunnel region. This is to be contrasted to the cranking model where sufficient energy must always be available to drive the system. The expressions for the mass parameters are given in terms of expectation values of few-body operators. The case of uniform translation of the nucleus as a whole is studied in detail. The generalized Hill–Wheeler method as described above produces the correct mass (= total nuclear mass). This rigorous reproduction of a known result allows the study of approximations which become necessary for the general case of deformations. Comments are made about the potential energy of deformation surface, which is expected to lie lower than the expectation value of the Hamiltonian. (auth)

17091 SEPARABLE-PAIR METHOD. Goss, D. (Nebraska Wesleyan University, Lincoln, Nebraska 68504). Phys. Rev. C 7: No. 4, 1348-1355 (Apr 1973).

A method for describing the motion of many-body systems that interact solely through two-body forces is introduced. The general form of the Hamiltonian is found, and applied to the case of particles interacting through Hooke's law forces. The general form of the wave function is exhibited and the means of antisymmetrization discussed. It is shown that the kinetic energy of the center of mass can be separated from the Hamiltonian by transforming to a new set of external (pair c.m.) coordinates. A particular approximation to the system boundary conditions is applied to light nuclei, and some of the implications of the use of current nucleon–nucleon forces discussed. (auth)

17092 INDEPENDENT FADDEEV AMPLITUDES IN THE THREE-NUCLEON PROBLEM. Kim, Y. E.; Tubis, A. (Department of Physics, Purdue University, Lafayette, Indiana 47907). Phys. Rev. C 7: No. 4, 1710-1712 (Apr 1973).

A straightforward procedure is given for determining the independent three-nucleon Faddeev amplitudes for the case of nucleon–nucleon interactions in a given set of partial waves. As an example, the independent positive-parity amplitudes for total trinucleon angular momentum and isospin 1/2 are given for the case of J and L (nucleon–nucleon) ≤ 2. It is shown that three of the independent Faddeev amplitudes were neglected by Gignoux and Laverne in their recent paper on the three-nucleon bound state. (auth)

17093 VARIATIONAL METHOD FOR DENSE SYSTEMS. Pandharipande, V. R.; Bethe, H. A. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. C 7: No. 4, 1312-1328 (Apr 1973).

The variational method for calculating energy of quantum fluids, and its applications to the Bose liquid ^{4}He, Fermi neutron gas, and liquid ^{3}He are discussed. The correlation functions are parameterized by their healing distance, and can depend on the states occupied by the correlated particles in the model wave function. They are calculated by constrained variation of the lowest-order contributions. The healing distance has a prescribed value in lowest-order calculations, whereas it is sufficiently large in hopefully exact energy calculations. The many-body cluster contributions in Bose fluids are summed with successive approximations of an integral equation due to van Leeuwen et al. A simple diagrammatic cluster expansion is presented for Fermi liquids, and its direct diagrams are summed with the integral equation. The contribution of exchange diagrams is shown to decrease rapidly with the number of exchanges, and their sums are truncated after the energy has converged to within a few percent. (auth)

17094 EXCHANGE EFFECTS IN NUCLEAR PARITY VIOLATIONS. Henley, Ernest M. (Department of Physics, University of Washington, Seattle, Washington 98195). Phys. Rev. C 7: No. 4, 1344-1347 (Apr 1973).

Exchange effects are examined for nuclear parity violating experiments which use photons as detectors. The weak coupling to vector (or axial vector) mesons which decay to $\pi\gamma$ are treated in detail. The effect is found to be small ($\lesssim 10^{-9}$) unless the existence of the recent $\pi\gamma$ resonance observed at 270 MeV is confirmed. (auth)

17095 CENTER-OF-MASS MOTION IN MANY-PARTICLE SYSTEMS. II. CRITIQUE OF THE GARTENHAUS-SCHWARTZ TRANSFORMATION. Ernst, D. J.; Shakin, C. M.; Thaler, R. M. (Physics Department, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 7: No. 4, 1340-1343 (Apr 1973).

We examine the Gartenhaus and Schwartz (G-S) transformation, which generates a translationally invariant wave function from one which does not possess this property. A clarification of the G-S procedure for the calculation of matrix elements is achieved if one takes two independent limits of the parameters Λ,Λ' which appear in the expression for a transformed operator $A' = (^{\lim}{}_{\Lambda'\to\infty} U^{\dagger}{}_{\Lambda'}) \times A(^{\lim}{}_{\Lambda\to\infty} U_{\Lambda})$. It is shown that the G-S operator, $U = {}^{\lim}{}_{\Lambda\to\infty} U_{\Lambda} = {}^{\lim}{}_{\Lambda\to\infty} \exp[-(1/2)i\Lambda\,(\vec{R}\cdot\vec{P} + \vec{P}\cdot\vec{R})$, is equivalent to the operator $U = (2\pi)^3\delta(\vec{P})\,\delta(\vec{R})$. This operator is seen to be a specific example of the more general class of operators presented earlier. (auth)

17096 EXCHANGE INTERPRETATION OF THE LARGE-ANGLE SCATTERING OF ALPHA PARTICLES FROM NUCLEI. Agassi, D. (Center for Theoretical Physics and Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742); Wall, N. S. Phys. Rev. C 7: No. 4, 1368-1382 (Apr 1973).

The anomalous large-angle scattering of medium-energy α particles is interpreted in terms of an exchange process. An exchange amplitude ("knock on"), calculated in the distorted-wave Born approximation, is evaluated paying particular attention to the antisymmetrization of the A+4 nucleon system. This amplitude is combined with a scattering matrix appropriate to fit just forward-angle elastic scattering. It is shown that only the highest possible orbital angular momentum cluster (L=8 for ^{40}Ca) is significant and leads to agreement with experiment. This agreement is achieved with only one adjustable parameter, the spectroscopic factor, which turns out to be quite small. It is shown that this microscopic calculation may provide a basis for the phenomenological Regge pole description of this process. (auth)

17097 SURVEY OF SOME NUCLEAR PROPERTIES GIVEN BY A NONLOCAL SEPARABLE NUCLEON-NUCLEON INTERACTION. Elbaz, E.; Fayard, C.; Lamot, G-H.; Meyer, J.; Nahabetian, R. S.; (and others) (Institut de Physique Nucléaire, Université Claude Bernard de Lyon-1 43, Bd du 11 novembre 1918, 69621 Villeurbanne, France). Phys. Rev. C 7: No. 4, 1445-1454 (Apr 1973).

We have determined a set of parameters for a nonlocal separable nucleon–nucleon interaction of the Mongan's case IV form. The M-5 potential thus defined, even if it remains with a poor D-state percentage (1.4%), is shown to give a correct description of the saturation of infinite nuclear matter. It appears also that M-5 gives a correct description of the following nuclear properties: two-nucleon elastic scattering phase shifts below 400 MeV (the phase shifts in the $^3S_1 + {}^3D_1$ state are those given by the M-IV Mongan's potential, not better) deuteron binding energy and quadrupole moment, scattering length and effective-range low-energy parameters, triton binding energy in a coupled three-body treatment, saturation of infinite nuclear matter, and first-order binding energy of some spherical nuclei. We have compared the results obtained with M-5 and a Tabakin force in a Hartree-Fock description of some even-even nuclei in the 2s-1d-shell nuclei as previously done by Ford, Braley, and Bar-Touv. (auth)

17098 UNIFIED DESCRIPTION OF PHENOMENOLOGICAL MODELS OF GROUND-STATE BANDS IN EVEN-EVEN NUCLEI. Mantri, A. N.; Sood, P. C. (Nuclear Physics Section, Department of Physics Banaras Hindu University, Varanasi, India 221005). Phys. Rev. C 7: No. 4, 1294-1305 (Apr 1973).

A generalized stretching model for the description of the ground band levels in even-even nuclei is developed under the provision that the higher-order cranking corrections and Coriolis-antipairing effects, as well as the corrections due to quadrupole centrifugal stretching, are all effectively included in the stretching term expressible in terms of a "generalized stretching variable" t. A basic set of equations is derived by writing the nuclear moment of inertia I as a function of t as $I_0 f(t)$. It is shown that practically all the successful two- and three-parameter models advanced during the past few years can be obtained from this basic set of equations through appropriate choices for f(t). For example, a linear cutoff in the Taylor's expansion for f(t) gives the equations of the variable moment-of-inertia model. The interrelationships, and the correspondence of respective parameters, in various models are established. Further, it is shown that, for models in which f(t) is also an explicit function of the nuclear spin I, the effective moment of inertia for excited states is renormalized from the value $I_0 f(t)$ by an additional spin-dependent term. (auth)

17099 REPLY TO "INDEPENDENT FADDEEV AMPLITUDES IN THE THREE-NUCLEON PROBLEM". Gignoux, C.; Laverne, A. (Institut des Sciences Nucléaires, BP 257, Centre de Tri – 38044 Grenoble, France). Phys. Rev. C 7: No. 4, 1713-1713 (Apr 1973).

The choice of the basis states for the Faddeev amplitude should be dictated by the actual computation for the interaction considered. (auth)

17100 MODELS AND SUM RULES FOR NUCLEAR TRANSITION DENSITIES. Deal, T. J.; Fallieros, S. (Department of Physics, Brown University, Providence, Rhode Island 02912). Phys. Rev. C 7: No. 4, 1709-1710 (Apr 1973).

Sum rules for isoscalar transition densities are written down. The sum-rule limits are space-dependent quantities which are shown to be simply related to transition densities previously obtained from models of collective nuclear excitations. (auth)

17101 APPLICATION OF THE BRUECKNER THEORY TO THE LIPKIN, MESHKOV, AND GLICK MANY-BODY HAMILTONIAN. Harada, Minoru (Institute of Liberal Arts, Otaru University of Commerce, Otaru, Hokkaido 047, Japan). Phys. Rev. C 7: No. 4, 1724-1725 (Apr 1973).

The ground-state energy of the Lipkin, Meshkov, and Glick many-body Hamiltonian as determined by the Brueckner theory is shown to be an upper bound on the exact value for 2, 3, 4, 6, and 8

particles. Improved upper bounds are obtained for 2, 4, 6, and 8 particles by taking one half of the usually adopted hole-state potential. This latter result lends support to Tobocman's early conjecture about the choice of the self-consistent single-partice potential. (auth)

17102 ALPHA-STRUCTURE AMPLITUDES FOR THE ^1p SHELL. Kurath, D. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. C 7: No. 4, 1390-1395 (Apr 1973).

Structure amplitudes for transfer of a $(1p)^4$ group with spatial symmetry [4] are given for 1p-shell targets with initial and final states represented by intermediate-coupling wave functions. The strength is fragmented, a feature likely to be even stronger in heavy nuclei as is shown for the (2p,1f) region. (auth)

17103 ASYMMETRY IN NUCLEAR FISSION. Mustafa, M. G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830); Mosel, U.; Schmitt, H. W. Phys. Rev. C 7: No. 4, 1519-1532 (Apr 1973).

The two-center shell model for fission has been generalized to include asymmetric deformations. The calculation of the potential energy involves four independent shape variables, where only two were required in the symmetric calculations. Potential energy calculations have been carried out for ^{202}Pb, ^{210}Po, ^{236}U, ^{248}Cm, ^{252}Fm, ^{258}Fm, and ^{264}Fm. Asymmetric fission is found to be energetically preferred in ^{236}U, ^{248}Cm, and ^{252}Fm; and symmetric fission is preferred in ^{202}Pb, ^{210}Po, ^{258}Fm, and ^{264}Fm. Two of these nuclei, namely ^{236}U and ^{210}Po, have been studied in detail. It is seen that the asymmetry in ^{236}U remains almost constant from the second saddle to scission, whereas in ^{210}Po (and also in ^{202}Pb), the preferred shape changes from asymmetry in the region of the second saddle to symmetry in the region of scission. The results for Fm isotopes indicate that there is a transition from asymmetric fission in the lighter Fm isotopes to symmetric fission in the heavier Fm isotopes. The preference for symmetric mass division in ^{264}Fm is very strong, since two double-magic $^{132}_{50}Sn_{82}$ fragments are formed at symmetry. In general, the structures which appear in the potential- energy surfaces are the results of an interplay between compound-nucleus shell structure, fragment shell structures, and liquid-drop-model energies. Comparisons of our results with experimental observations indicate that the observed mass distribution is correlated with the potential energy surface in the neighborhood of scission. (auth)

17104 A CLASS OF EXACTLY SOLVABLE THREE-PARTICLE PROBLEMS. Fuda, Michael G. (Department of Physics and Astronomy, State University of New York at Buffalo, Buffalo, New York, 14214). Phys. Rev. C 7: No. 4, 1365-1367 (Apr 1973).

It is shown that the amplitudes for elastic scattering, inelastic scattering, and breakup can be found in closed form for a system of three nonidentical particles interacting via a single two-particle potential and a separable three-particle potential. For a zero-range two-particle force and a particular form of the factors arising in the three-particle potential, the various integrals that arise are evaluated and the amplitudes are given in terms of elementary functions. (auth)

17105 ABSOLUTE NORMALIZATION IN DISTORTED-WAVE BORN-APPROXIMATION ANALYSIS OF TWO-NUCLEON-TRANSFER-REACTION CROSS SECTIONS. Lim, T. K. (Department of Physics and Atmospheric Science, Drexel University, Philadelphia, Pennsylvania 19104). Phys. Rev. C 7: No. 4, 1288-1293 (Apr 1973).

The normalization constants for two-nucleon-transfer reactions are determined by the direct and parameterization methods. The results are compared between themselves and with experiment. Both methods give rise to calculated values which fall short by at least a factor of 3. (auth)

17106 RECOIL EFFECTS IN HEAVY-ION REACTIONS. Nagarajan, M. A. (Univ. of California, Berkeley). Nucl. Phys.; A209: No. 3, 485-492(30 Jul 1973).

Expressions for the recoil effects in single-nucleon transfer in heavy-ion reactions are obtained in first order in the mass ratio (m/M), where m is the mass of the transferred nucleon and M is the mass of either of the nuclear cores. The effect of recoil on the j-dependence, the energy dependence, and angular momentum of the residual nucleus is predicted. (auth)

17107 RENORMALIZATION OF THE AXIAL-VECTOR COUPLING CONSTANT IN NUCLEAR β-DECAY. II. Wilkinson, D. H. (Oxford Univ., Eng.). Nucl. Phys.; A209: No. 3, 470-484(30 Jul 1973).

A systematic comparison is made between the experimental strengths of accurately measured allowed Gamow–Teller β decay and the corresponding strengths derived from shell model wave functions computed in the full basis of the major shell. It is found that the experimental transitions are, on the average, slower than the theoretical by the square of $\rho_\psi = 0.897 \pm 0.035$. This is to be compared with the outcome of an earlier study in which a corresponding factor was extracted in an almost-wave-function-free way using the isoscalar magnetic moments of mirror pairs which gave $\rho_\mu = 0.902 \pm 0.046$. (auth)

17108 REDUCTION OF l-WAVES TO s-WAVES FOR CENTRAL POTENTIALS. Goodmanson, D.; Taylor, J. R. (Univ. of Colorado, Boulder). Nucl. Phys.; A210: No. 1, 211-220(1973).

It is shown that, for any central potential, V(r), and any angular momentum, l, it is possible to construct an "s-equivalent" potential, $\bar{V}$ (r), such that the s-wave amplitude for $\bar{V}$ is exactly equal to the l-wave amplitude for V. This result is used to prove that the enhancement factor in the theory of final-state interactions is greater or less than 1 according as V corresponds to an attractive or repulsive force. (auth)

17109 SEQUENTIAL DECAY OF LIGHT FRAGMENTS IN HEAVY ION REACTIONS. Bondorf, J. P.; Noerenberg, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 44B: No. 6, 487-490(11 Jun 1973).

A new interpretation of the production of light nuclei in heavy-ion reactions is presented. Yields and kinetic energies result from sequential decay by nucleons and α particles of excited primary fragments formed by inelastic scattering or few-nucleon transfer. (auth)

17110 ENERGY LEVELS OF THREE RESONANTLY INTERACTING PARTICLES. Efimov, V. (Leningrad Nuclear Physics Inst.). Nucl. Phys.; A210: No. 1, 157-188(1973).

As shown recently, resonances in the pairwise forces result in the appearance of a specific series of levels in the three-particle spectrum. The number of levels may be very large, they lie near the three-body break-up threshold, have characteristic quantum numbers and are of large spatial size. A detailed analysis of this effect is given for various particle mass ratios. The effect is shown to exist at all mass ratios, the resonances acting in the forces of all the pairs or two pairs of particles only. The most favorable for the appearance of the series is the case of one particle being much lighter than the other two, while interacting resonantly with them. The physical pattern of the effect, the level spectrum structure and the spatial structure of the states are studied for all mass ratios. The studies of the effect permit one to draw some qualitative conclusions concerning the character of the overall three-particle level spectrum. (auth)

17111 REVERSIBILITY OF STRIPPING REACTIONS. Seglie, E.; Inglis, D. R. (Univ. of Massachusetts, Amherst). Nucl. Phys.; A210: No. 1, 105-125(1973).

The basis for the equivalence of prior and post forms of the T-matrix in both the Born and the distorted wave Born approximations is here studied in a one-dimensional model that facilitates clarification of some of the underlying mechanism. One sees how important it is that changes in the wave functions bring it about that averages of different perturbing potentials over different regions can still be equal. The post form commonly employed for a (d,p) reaction makes it seem at first sight that the potential stripping the deuteron apart is the potential that holds it together. The prior form DWBA has as a perturbation the intuitively appealing interaction responsible for the classical break-up of the deuteron and contributing to the "surface reaction" nature of stripping. (auth)

17112 SEMI-CLASSICAL INTERPRETATION OF THE VECTOR ANALYZING POWER IN SUB-COULOMB NEUTRON-TRANSFER REACTIONS. Vigdor, S. E.; Rathmell, R. D.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A210: No. 1, 93-104 (1973).

Sub-Coulomb neutron-transfer reactions are considered in a classical model in which the incident and outgoing projectiles follow Coulomb scattering trajectories with coincident turning points. The dependence of the vector analyzing power on bombarding energy and Q-value, and the angular dependence of the cross section are explained. The sign of the analyzing power is related directly to the total angular momentum transfer. Predictions of the model for (d̄,p) and d̄,t) reactions are compared with DWBA calculations employing only Coulomb distortions. Limitations of the model are discussed. (auth)

17113 GENERAL EXPRESSION OF THE DENSITY MATRIX AND ITS IRREDUCIBLE DECOMPOSITION FOR TENSORIAL WAVE FUNCTIONS. Kalinauskas, R. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; XIII: No. 1, 25-32(1973). (In Russian).

Various types of the fractional parentage decomposition for wave functions, used in the theory of nucleus, atomic, and molecular spectra are discussed and the corresponding density matrices are introduced. The general irreducible decomposition of the density matrix in a case of tensorial wave functions is presented. (auth)

17114 PREDICTIONS FOR INCLUSIVE PARTICLE–NUCLEUS REACTIONS AT ACCELERATOR AND COSMIC-RAY ENERGIES. Fishbane, P. M. (Univ. of Virginia, Charlottesville, VA); Trefil, J. S. Nucl. Phys.; B58: No. 1, 261-268(1973).

Using a recently developed theory of inclusive scattering on nuclei and the assumption that the primary collision mechanism is incoherent (e.g., multiperipheral), some quantities of immediate experimental interest in inclusive hadron–nucleus scattering are derived. (auth)

17115 NONOVERLAPPING POTENTIALS AND THE ERICSON–ERICSON RENORMALIZATION IN THE PION–NUCLEUS OPTICAL POTENTIAL. Huefner, J. (Univ., Freiburg i. B.). Nucl. Phys.; B58: No. 1, 55-76(1973).

Do hadron–nucleus scattering amplitudes and properties of exotic atoms depend on the off-shell values of the elementary hadron–nucleon scattering amplitude? This problem is investigated within a multiple scattering formalism based on the frozen-nucleus approximation. If repulsive nucleon-nucleon correlations prevent the overlap of the various hadron–nucleon interaction regions, only on-shell values are needed. For this case, an expansion of the optical potential is proposed which preserves the on-shell property at each level of approximation. In lowest order, the Ericson–Ericson renormalization is recovered for the impulse approximation to the optical potential. Properties of the local and non-local forms of the π-nucleus optical potential are proven. Multiple scattering in the presence of the Coulomb potential is formulated and a kind of minimal-coupling prescription is derived. (auth)

17116 FINITE TEMPERATURE CALCULATION OF ANGULAR VELOCITIES AND MOMENTS OF INERTIA ROTATING NUCLEI. Moretto, L. G. (Univ. of California, Berkeley). Phys. Lett.; 44B: No. 6, 494-496(11 Jun 1973).

The rotational properties of nuclei in the statistical region are predicted on the basis of a simple BCS model. A back-bending, which disappears as the temperature increases, is observed in the plot of the moment of inertia versus the square of the angular velocity. (auth)

17117 UNITARY SCHEME DENSITY MATRIX IN A CANONICAL SU(3)-BASIS. Petrauskas, A. K.; Yankauskas, K. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; XIII: No. 1, 33-44(1973). (In Russian).

The construction of the unitary scheme density matrix in a canonical SU(3)-basis was considered. It was shown that this matrix may be obtained from the unitary scheme density matrix in a noncanonical SU(3)-basis by means of the substitution of the Clebsch–Gordan coefficients of the chain subgroup SU(3) $\supset$ SU(2) for the coefficients of the chain subgroup SU(3) $\supset 0^+(3)$. The calculation of matrix elements of central Wigner and Majorana forces in a canonical SU(3)-basis was discussed and their expressions for E_{min} states for nuclei with $n \leq 16$ were presented. (auth)

17118 SOME APPROXIMATIONS IN THE THEORY OF MOMENTS AND TRANSITIONS FOR EVEN-ODD NUCLEI. Weigel, M. (Univ. of California, Berkeley). Fortschr. Phys.; 20: No. 10, 595-627(1972).

In the framework of Green's functions, the theory of moments and transitions for even-odd-nuclei is developed. It is shown, how these quantities are connected with the effective particle-hole force and the generalized linear response function for the neighbor even-even nuclei. The response function describes the change of the single-particle propagator due to an external perturbation. For superfluid systems the Nambu–Engelsberg–Belyaev technique was used. The connection between earlier treatments is established, especially with the semiphenomenological approach of Migdal and co-workers. Some approximations for the relevant effective particle-hole force emerging from the many-body theory are discussed in detail. Furthermore the generalization of the RPA-approximation for the auto-correlation function of density fluctuations in the case of superfluidity is given. (auth)

17119 MAXIMUM-OVERLAP ORBITALS. Meldner, H. W. (Institute for Pure and Applied Physical Sciences, University of California at San Diego, La Jolla, California 92037); Perez, J. D. Phys. Rev. C 7: No. 5, 2158-2160 (May 1973).

It is shown that Kobe has not proven the absence of rearrangement terms in the Euler–Lagrange equation for maximum–overlap orbitals for realistic (approximate) reaction–operator calculations. (auth)

17120 INFLUENCE OF EXCHANGE UPON THE NUCLEON-NUCLEUS OPTICAL POTENTIAL AT INTERMEDIATE AND HIGH ENERGY. Scheerbaum, Robert R. (Department of Physics, Case Western Reserve University, Cleveland, Ohio 44106). Phys. Rev. C 7: No. 5, 2166-2170 (May 1973).

When proper account is taken of the identity of the incident and target nucleons in nucleon–nucleus scattering, exchange processes occur which are ignored in the usual treatments of the optical potential. We have calculated the lowest order exchange process for scattering from ^{16}O and ^{40}Ca. We find that it is generally a few percent of the leading term and that it may have significance for studies of two–body correlations in nuclei. (auth)

17121 OFF-SHELL CORRECTION TO THE HIGH-ENERGY OPTICAL POTENTIAL. Moniz, E. J. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). Phys. Rev. C 7: No. 5, 1750-1759 (May 1973).

We obtain the leading off-shell correction to the high-energy optical potential: $v = v_0\,[1-(\gamma/2k^2)v_0]$, where $\gamma = k[(\partial/\partial q)\ln f(q;k)]_{q=k}$ for $f(q;k) = f(\tilde{q},\tilde{q};k)$, the off-shell projectile-nucleon scattering amplitude. A slow energy variation of the amplitude at very high energy gives $\gamma = k(\partial/\partial k)\ln f_k(0)$, where $f_k(0)$ is the on-shell amplitude, and the correction is small. In the region of projectile-nucleon resonances, we describe the two-body interaction by a separable potential and relate γ to the scattering phase shifts. The leading off-shell correction is substantial for an absorptive resonance but "anomalously" small at an elastic resonance. (auth)

17122 CONVERGENCE RATE OF INTERMEDIATE-STATE SUMMATIONS IN THE EFFECTIVE SHELL–MODEL INTERACTION. Vary, J. P. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973); Sauer, P. U.; Wong, C. W. Phys. Rev. C 7: No. 5, 1776-1785 (May 1973).

We examine the convergence rate of the sum over intermediate particle states in the second–order core–polarization diagram of the effective shell–model interaction. For a G matrix resulting from the Reid soft–core interaction, convergence is achieved in an oscillator basis only after the intermediate particle is summed over five or six major shell excitations ($10\hbar\Omega$ to $12\hbar\Omega$ excitations). The total effect of this diagram on the shell–model spectra of ^{18}O is markedly altered from the results of the Kuo and Brown and others who only include oscillator excitations of one major shell ($2\hbar\Omega$) in the second–order diagram. We further demonstrate that slow convergence is attributed to strong components of the effective tensor force in the G matrix. (auth)

17123 NORMALIZATION OF SHELL–MODEL NUCLEI TO LIQUID–DROP–MODEL NUCLEI. Hillman, Manny (Brookhaven National Laboratory, Upton, New York 11973). Phys. Rev. C 7: No. 5, 2037-2040 (May 1973).

Three methods for the normalization of shell–model nuclei to liquid–drop–model nuclei are described and evaluated. The first, the familiar Strutinsky method, is sensitive to the number of levels above the Fermi level used and is not readily applicable to a single–particle model using a finite potential well. The second method involves the smoothing of the single–particle energies by means of an arbitrary function fitted in the least–squares sense. The third method involves the assumption that the need for the normalization lies in the inadequacy of the volume–correction term used in the calculation of the single–particle energies. Using an arbitrary function fitted by least squares, the best volume–correction function is found that causes the shell–model ground–state energies to be normalized to the liquid–drop–model energies. This method involves only the levels up to the Fermi level and consequently is readily applicable to a finite potential well. (auth)

17124 ROTATION OF MODERATELY DEFORMED ODD–A NUCLEI. Stephens, F. S.; Diamond, R. M.; Benson, D. Jr.; Maier, M. R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). Phys. Rev. C 7: No. 5, 2163-2166 (May 1973).

The particle–plus–rotor model has been solved for some weakly and moderately deformed odd–A nuclei. Some very characteristic regularities are expected to occur for the high–spin states coming from high–j orbitals, and these depend strongly on the sign of β. Application to some Au, Hg, and Tl nuclei shows surprising agreement, and indicates oblate shapes for these states in all these nuclei. Under certain conditions, a new coupling scheme is realized where the particle angular momentum, j, is quantized along the rotation axis rather than the symmetry axis. (auth)

17125 MICROSCOPIC CALCULATION OF FISSION–FRAGMENT ANISOTROPIES FOR NUCLEI EXHIBITING A DOUBLE BARRIER. Vandenbosch, R. (University of Washington, Seattle, Washington 98195). Phys. Rev. C 7: No. 5, 2092-2097 (May 1973).

At moderate excitation energies fragment angular distributions are determined by an effective moment of inertia characteristic of the saddle–point deformation. We have performed a microscopic calculation which shows that at low excitation energy the experimentally deduced effective moment of inertia corresponds to the outer barrier. This is consistent with recent theoretical calculations showing that the inner barrier is unstable with respect to distortions destroying axial symmetry of the nuclear shape. At higher excitation energies the effective moment of inertia becomes characteristic of the liquid–drop–model saddle deformation. The transition is expected to occur at a fairly high excitation energy and may provide an explanation for the observation that the effective moment of inertia continues to increase at excitation energies well above that where pairing effects have disappeared. (auth)

17126 EMBEDDING OF THE BRUECKNER APPROXIMATION IN THE EXTENDED JASTROW SCHEME.

Clark, J. W. (Institutionen för Fysik, Abo Akademi 20500 Abo 50, Finland); Ristig, M. L. Phys. Rev. C 7: No. 5, 1792-1803 (May 1973).

A nonperturbative derivation of the Brueckner approximation to the ground-state energy of nuclear matter (with standard choice of hole and particle energies) is given within the framework of the method of correlated basis functions. The structure of the factor-cluster (FIY) expansion of the expectation value of the Hamiltonian with respect to a trial function incorporating short-range correlations in a general fashion, is analyzed for a uniform extended medium of fermions. With a special choice of correlated wave function, the Brueckner approximation is extracted from the FIY expansion by selective summation of two-body combination terms to all orders in the smallness parameter κ associated, in this case, with both Brueckner-Bethe-Goldstone and FIY energy expansions. A reexamination of the numerical comparison of conventional Brueckner and Jastrow methods carried out earlier for two simple models of nuclear matter leads to the conclusion that it is inadvisable, at least in a Jastrow calculation satisfying the average Pauli condition, to incorporate the $O(\kappa)$ contribution of the analog of the dispersion correction of reaction-matrix theory without at the same time including the $O(\kappa)$ contribution of the analog of the Bethe-Faddeev term. For the uniform extended medium and the Jastrow choice of wave function, there is a formal cancellation of these two three-body contributions, the scale of this cancellation being governed by the size of κ. In the numerical example considered, κ is about 0.22 and the cancellation goes something like +14 MeV-15 MeV=-1 MeV. These findings, when juxtaposed with the standard Brueckner results for the simple models in question, suggest that a departure from the standard prescription of hole and particle energies in reaction-matrix theory may be necessary when κ is sizeable—as in liquid ^{3}He and the high-density neutron gas, as well as equilibrium nuclear matter described with some potentials. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

Refer also to abstract 17230.

17127 COMPARISON OF THE HOT-ELECTRON PLASMAS PRODUCED USING TWO DIFFERENT PLASMA SOURCES IN A MAGNETIC MIRROR COMPRESSION EXPERIMENT. DeNeef, C. P.; Pechacek, R. E.; Trivelpiece, A. W. (University of Maryland, College Park, Maryland 20742). Phys. Fluids 16: No. 4, 509-515 (Apr 1973).

The hot-electron plasma produced in a single-stage magnetic mirror compression experiment using a deuterated titanium washer stack source is compared with the nonneutral hot-electron plasma produced using a thermionic electron gun source. Both plasmas contain approximately 5×10^{11} electrons with 0.3-MeV mean energy and 0.3-MeV temperature at the peak magnetic field of 18.5 kG, and both remain trapped for more than 20 msec. These plasmas are similar because deuterated titanium washer stack sources are electron sources during the first few μsec of operation and because the electron dynamics during compression is not strongly affected by the ion dynamics. The effect of the plasma self fields upon synchrotron radiation is investigated. The properties of these plasmas are compared with three other pulse compression hot electron plasmas obtained using a washer stack source. (auth)

17128 BIFURCATION AND STABILITY OF LONG-WAVELENGTH HELICAL HYDROMAGNETIC EQUILIBRIA. Yeh, Tyan (Department of Mathematics, Southern Illinois University, Carbondale, Illinois 62901). Phys. Fluids 16: No. 4, 516-528 (Apr 1973).

When a plasma is confined by magnetic fields inside a cylindrical conducting wall, the configuration of equilibrium can have either circular symmetry or helical symmetry. Thus, a sharp-boundary screw pinch can have a circular or helical interface between the plasma and the vacuum. Each possesses the same amounts of total plasma mass, axial magnetic flux in plasma, axial magnetic flux in vacuum, and total azimuthal magnetic flux. It is shown that in the neighborhood of a point of bifurcation there are stable long-wavelength helical equilibria. The equivalent circular equilibria with the same plasma mass and magnetic fluxes are unstable. (auth)

17129 SYNCHROTRON RADIATION FROM A MAGNETICALLY-CONFINED NONNEUTRAL HOT-ELECTRON PLASMA. Nee, S. F.; Trivelpiece, A. W.; Pechacek, R. E. (University of Maryland, College Park, Maryland 20742). Phys. Fluids 16: No. 4, 502-508 (Apr 1973).

The spectrum of the synchrotron radiation emitted by the hot-electron plasma produced in the University of Maryland pulsed magnetic mirror compression experiment has been measured in the 3.0-cm to 0.3 mm wavelength region. The measured spectra are compared with those calculated using a theoretical model for the electron distribution function that conserves the magnetic moments of the trapped electrons during magnetic compression of the hot electron plasma. (auth)

17130 ELECTRON TEMPERATURES AND THERMAL CONDUCTION IN HIGH-ENERGY θ PINCHES. Morse, Richard L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). Phys. Fluids 16: No. 4, 545-549 (Apr 1973).

The common occurrence of electron temperatures of a few hundred electron volts in θ-pinch experiments is shown by simple analytic arguments to be rather tightly determined by a balance between energy gained from collisions with the much higher-temperature ions and thermal conduction to material walls. It is also shown that electron thermal conduction should not cause a greater loss of energy from straight θ pinches of any length than ion end loss unless rather large magnetic mirror ratios can be obtained. This applies in particular to straight θ-pinch fusion feasibility experiments and fusion reactors. Also several suggestions are presented for reducing end losses and heating plasma columns. (auth)

17131 HEATING OF HIGH-Z PLASMA BY LASER. Kang, H. B. (Nagoya Univ., Japan); Waki, M.; Yoshida, K.; Sakagami, Y.; Yamanaka, T. J. Phys. Soc. Jap.; 34: No. 2, 504-512(Jan 1973).

The properties of plasmas produced by high-power lasers were investigated. The laser beam was irradiated on the various targets of beryllium, carbon, and polyethylene of high z number. The influence of the charge number z to the heating of the plasma was discussed. The electron temperatures of plasmas from different targets were estimated by the measurement of soft x-rays. The time variations of the reflected laser light from plasma were also investigated. From the time-of-flight measurements with a Faraday cage and an electrostatic energy analyser, the different charged ions could be separated and ion temperatures and drift velocities were obtained from their velocity profiles. No influence of laser pulse duration to the temperature was observed in the cases of durations 2ns, 4ns and 10ns. The experimental results for fast rising laser pulses were discussed and compared with those for slow rising ones. (auth)

17132 ALL-METAL LINER FOR rf HEATING. Consoli, T.; Jefferoy, G.; Nagao, S.; Zymanski, S. (CEN, Grenoble, France). Nucl. Fusion; 13: No. 3, 423-431(Jun 1973).

The future of rf heating and rf stabilization of a plasma, particularly in toroidal devices, depends strongly on the possibility of excluding any insulating material round the plasma. The paper describes various metallic liners which are transparent to the rf field, are bakeable, can be cooled, have a high Q value and can be located between the rf coil and the vacuum wall. Calculations and experiments made in the absence of plasma are discussed. (auth)

17133 EXPERIMENTS ON PLASMA CONFINEMENT IN INTERNAL-RING DEVICES. Yoshikawa, S. (Princeton Univ., NJ). Nucl. Fusion; 13: No. 3, 433-449(Jun 1973).

Internal-conductor devices for low-β toroidal confinement are reviewed. These devices are characterized by high stability against low-frequency oscillations. Experimental observations amply demonstrate this stability property. Plasma confinement approaching the classical limit has been observed in a limited range. It is also shown that the confinement time exceeds the so-called Bohm time by a factor of 200 to 300. The plasma confinement is remarkably sensitive to nonideal effects such as field error, existence of symmetry-spoiling supports and concentration of impurities. (auth)

17134 CLEO TOKAMAK NEUTRAL INJECTION SYSTEM. Aldcroft, D.; Burcham, J.; Cole, H. C.; Cowlin, M.; Sheffield, J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion; 13: No. 3, 393-400(Jun 1973).

An intense beam of neutral hydrogen atoms will be injected into the plasma of the CLEO Tokamak. This beam will be used to provide additional heating of the plasma and for a general investigation of the beam–plasma interaction. It is estimated that a 60-kW beam, of 50 ms duration at 30 keV will raise the plasma temperature by typically 10%. A neutral-injection system which meets this minimum requirement is described. (auth)

17135 WAVELENGTH DEPENDENCE OF LASER-LIGHT ABSORPTION BY A SOLID-DEUTERIUM TARGET. Shearer, J. W. (Univ. of California, Livermore); Duderstadt, J. J. Nucl. Fusion; 13: No. 3, 401-412(Jun 1973).

The efficiency of absorption of laser light by a deuterium plasma is an important parameter for the laser/pellet fusion application. A computer calculation model is described and used to calculate intense light absorption over the wavelength range $0.1\ \mu m \leq \lambda \leq 10.6\ \mu m$ for two different pulse durations. The calculation includes both collisional absorption and anomalous absorption by means of the parametric ion-acoustic instability. The general result for all of the computer calculations, supported by an analytic model, is that the absorption efficiency increases as the wavelength is decreased. (auth)

17136 STEADY-STATE PLASMA CONFINEMENT REGIME IN STELLARATORS WITHIN THE FRAMEWORK OF AN IDEALIZED COLLISIONAL DIFFUSION MODEL. Danikin, I. S.; Spiegel, I. S. (Lebedev Inst. of Physics, Moscow). Nucl. Fusion; 13: No. 3, 341-350(Jun 1973).

A model calculation is presented of a steady-state confinement regime in stellarators. Plasma is assumed to be injected continuously into the magnetic field region in conditions such that the plasma is isothermal and $T_e = T_i = T = \text{const}$ (or $d \ln T/d \ln N \ll 1$ in the whole of the confinement region considered), and the diffusion process is determined only by pair collisions with allowance for toroidal effects. The calculations relate to stellarators with different multipolarities of the helical field ($l = 2,3$) and one of the purposes was to compare the possibilities of stellarators as a function of this parameter. Analysis of the particle balance equation, allowing for a self-consistent electrical field and the effects of magnetic confinement in a highly dilute plasma, has shown that a steady-state plasma confinement regime under the conditions considered is not possible for arbitrarily low boundary values of density, $N_{bound} > N_{cr}$. When $N_{bound} < N_{cr}$, the only confinement regime possible is a relaxation regime with a time-pulsating density distribution. The results obtained for steady-state regimes are insensitive to the multipolarity of the helical field l and show that it is possible in principle to use stellarators as the prototype

of a thermonuclear reactor within the framework of the approach outlined. (auth)

17137 GENERATION OF ENERGETIC ELECTRONS BY ELECTRON CYCLOTRON HEATING IN A MAGNETIC MIRROR FIELD. Ikegami, H.; Aihara, S.; Hosokawa, M.; Aikawa, H. (Nagoya Univ., Japan). Nucl. Fusion; 13: No. 3, 351-361(Jun 1973).

Electron cyclotron heating that generates hot-electron plasma in a magnetic mirror trap by microwaves is studied experimentally. The evolution of the energy distribution functions for the high-energy electrons is observed in steps of milliseconds during 200 ms of the heating period from the initial stage at the microwave power input until the stationary final state. According to the proposed statistical model for the cyclotron heating, heating rates are estimated to be 10 MeV/s typically, in the three characteristic cases of mirror field configuration with heating microwave power as a parameter. Some problems associated with stochastic cyclotron heating are discussed in the light of the experiments. (auth)

17138 INHOMOGENEOUS EFFECT ON COIL-TO-PLASMA COUPLING IN AN ION CYCLOTRON WAVE. Toyama, H.; Matsuura, K. (Nagoya Univ., Japan). Nucl. Fusion; 13: No. 3, 363-368(Jun 1973).

The dependence of the absorbed rf-power on the diameter of the plasma column was examined experimentally in the density region of 10^{11} cm^{-3} to 2×10^{12} cm^{-3}, using a QP-machine. Setting the absorbed rf-power P proportional to d^{γ} (d is the diameter of the plasma column), the calculation for a uniform plasma column yields $\gamma = 4$. However, the experimental value of γ is less than 2. It is shown that the effect of an inhomogeneous density profile makes γ less than 2 and the density profile is important in the efficient heating of a plasma. (auth)

17139 ANOMALOUS PINCH EFFECT IN A TOKAMAK. Bussac, M. N.; Laval, G.; Pellat, R. (Association EURATOM-Commissariat à l'Energie Atomique sur la Fusion, Département de Physique du Plasma et de la Fusion Contrôlée, Centre d'Etudes Nucléaires, 92-Fontenay-aux-Roses, France, and Ecole Polytechnique, Centre de Physique Théorique, Paris V, France). Phys. Rev. Lett. 30: No. 13, 588-590 (26 Mar 1973).

We demonstrate the existence of an anomalous pinch effect if turbulent fields are generated by current instabilities. This effect is similar to the Ware effect, but the stationary electric force is replaced by the drag force resulting from asymmetry of the turbulent fields. (auth)

17140 ENHANCED LASER-LIGHT ABSORPTION BY OPTICAL RESONANCE IN INHOMOGENEOUS PLASMA. Müller, Marvin M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). Phys. Rev. Lett. 30: No. 13, 582-585 (26 Mar 1973).

The collisional absorption of laser radiation by a planar plasma was calculated using the classical physical optics of absorbing media. In most regions of interest to thermonuclear fusion, the enhanced absorption of p-polarized radiation by optical resonance—particularly at high temperatures and long laser wavelength—completely dominates the ordinary absorption due to inverse bremsstrahlung. (auth)

17141 TWO-STREAM INSTABILITY HEATING OF PLASMAS BY RELATIVISTIC ELECTRON BEAMS. Thode, L. E.; Sudan, R. N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. Lett. 30: No. 16, 732-735 (16 Apr 1973).

We discuss the two-stream interaction of relativistic electron beams with a plasma in the nonlinear regime supported by computer simulation experiments. (auth)

17142 AXIAL DISTRIBUTION FOR A HOT ELECTRON PLASMA. Haste, G. R.; Lazar, N. H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). Phys. Fluids 16: No. 5, 683-685 (May 1973).

Bremsstrahlung measurements have been used to determine the axial distribution of density and temperature in an electron cyclotron heating experiment. The results show two heating mechanisms. Low energy electrons turn at the resonance position and are resonantly heated. High energy electrons turn well inside their resonance position and are nonresonantly heated. (auth)

17143 AXIAL COMPRESSION OF THE ASTRON E-LAYER DURING NEUTRALIZATION. Christofilos, N. C.; Fowler, T. K. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). Phys. Fluids 16: No. 5, 713-715 (May 1973).

It is shown that, despite processes that tend to elongate the astron E-layer as it is built up by injecting successive pulses of electrons, in a good vacuum this tendency is overcome by the slow turn-on of focusing forces that compress the E layer as it slowly neutralizes. (auth)

17144 CORRECT VALUES FOR HIGH-FREQUENCY POWER ABSORPTION BY INVERSE BREMSSTRAHLUNG IN PLASMAS. Johnston, Tudor Wyatt (Institut de Recherche de l'Hydro-Quebec C. P. 1000, Varennes, Quebec, Canada); Dawson, John M. Phys. Fluids 16: No. 5, 722-722 (May 1973).

Numerical corrections are made to previous values for the power absorption coefficient and some common errors noted. (auth)

17145 EARLY-TIME MODEL OF LASER PLASMA EXPANSION. Book, D. L.; Clark, R. W. (Naval Research Laboratory, Washington, D. C. 20390). Phys. Fluids 16: No. 5, 720-721 (May 1973).

A realistic density profile is used to model the spherical expansion of a plasma into a stationary magnetized plasma. Magnetic compression develops where streaming and ambient densities are comparable. Peak magnetic intensities are typically much lower than predicted by Longmire's model. (auth)

17146 SATURATION IN CYCLOTRON RESONANCE HEATING OF PLASMA. Arunasalam, V. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 16: No. 5, 718-720 (May 1973).

It is shown that a nonlinear change in the distribution function may limit the maximum power that can be dumped into a plasma near cyclotron resonance if a finite $k_{\parallel}$ exists. (auth)

17147 EFFECT OF LASER PULSE RISE TIME ON HEATING OF A MAGNETICALLY CONFINED PLASMA. Nguyen, Duc-Long; Parbhakar, Kanwal J. (Institut National de La Recherche Scientifique INRS-Energie, Université du Québec, C. P. 1020, Varennes, Québec, Canada). J. Appl. Phys. 44: No. 5, 2157-2160 (May 1973).

For a magnetically confined plasma the effect of laser pulse rise time on heating is considered theoretically. The hydrodynamic equations are solved analytically in the asymptotic limit. We find that for a certain range the laser pulse energy requirement is quite sensitive to the rise time. By properly choosing the laser pulse rise time, the energy requirement can be decreased as much as 25%. The maximum radiation flux density is however not very sensitive and increases only slightly. It seems that fast-rising laser pulses are superior as far as flux is concerned but are inferior to slow-rising laser pulses from the point of view of energy requirement. (auth)

Diagnostics

Refer also to abstract 17236.

17148 DISCUSSION ON THE TRANSITION PROBABILITY OF THE 6032-A LINE OF Ar I DETERMINED BY SPECTROPHOTOMETRY IN DIFFERENT PLASMAS. Larcher, G.; Maillot, P.; Thenard, C. (Rouen Univ., Mont-Saint-Aignan, France). Compt. Rend., Ser. A, B; 276: No. 12, 463-465(19 Mar 1973). (In French).

In order to determine the electron temperature of an argon plasma, transition probability calculations were made for the 6023-A line of Ar I. The intensity of this line was measured by the spectrophotometry of the plasmas produced in a shock tube, in a high-frequency plasma torch, or in a plasma jet (in a rarefied atmosphere). The value obtained was of the order of 30×10^5 sec^{-1}. (FR)

17149 PLASMA-PROBE SELF DETECTION OF RESONANCE CONES. Balmain, K. G. (Univ. of Toronto). Electron. Lett.; 9: No. 14, 312-313(12 Jul 1973).

The near-field resonance cones that extend outward from a small antenna or probe in a magnetoplasma were detected at a second probe by utilizing the nonlinear rectification properties of the probe-plasma interface. Seen from the point of view of plasma diagnostics, this constitutes a very simple procedure for laboratory measurement of the electron plasma frequency when the electron gyrofrequency is known. (auth)

17150 DYNAMIC PRESSURE TRANSDUCER SYSTEM FOR PULSED PLASMA FLOW DIAGNOSIS. York, Thomas M.; McKenna, Kenneth F. (The Pennsylvania State University, University Park, Pennsylvania 16802); Michels, Charles J. Rev. Sci. Instrum. 44: No. 5, 588-591 (May 1973).

The response characteristics of high sensitivity piezoelectric pressure transducers suitable for use in the plasma flow induced by megawatt-level electric discharges in low density (< 1 Torr) gases are described. The uniquely designed probe records the initial impingement of a large magnitude total pressure pulse (10^4N/m^2 with 30μsec duration), followed by the flow of primary interest with order-of-magnitude smaller signals (10^3N/m^2 for 400 μsec). Effects relating to probe and support accelerations, blast shielding and probe heating are evaluated and accounted for in a probe system with a sensitivity of 40 V/atm. (auth)

17151 THEORY OF LIGHT SCATTERING FROM DENSE PLASMAS. Linnebur, E. J.; Duderstadt, J. J. (Department of Nuclear

Engineering, The University of Michigan, Ann Arbor, Michigan 48105). Phys. Fluids 16: No. 5, 665-674 (May 1973).

Projection operator techniques have been applied to derive a coupled set of exact kinetic equations describing microscopic density fluctuations in an infinite, fully-ionized, classical plasma in thermal equilibrium. The time dependence of the nonlocal collision terms in these equations is then approximated in such a way as to yield the correct short and long time behavior of density fluctuations, while allowing the explicit calculation of the dynamic structure factor $S(k,\omega)$ characterizing electron density fluctuations in classical plasmas of arbitrary density. This theory is then applied to analyze light scattering from dense, collision-dominated plasmas, and the results of these calculations are found to compare favorably with both experimental data as well as with earlier theories (at least in the regimes in which these earlier theories are valid). (auth)

17152 CONTINUUM ANALYSIS OF THE PHOTOIONIZATION CHAMBER IN THE TRANSITION FROM LOW TO HIGH RATES OF IONIZATION. Wardlaw, Andrew B. Jr.; Cohen, Ira M. (The Towne School of Civil and Mechanical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania, 19174). Phys. Fluids 16: No. 5, 637-650 (May 1973).

The photoionization chamber consists of a test gas which is bounded by parallel plates and ionized to a small extent by incident radiation. The charged particles formed by the ionization process diffuse to the walls of the chamber where they recombine. The particle densities and electric field distributions as well as the current-voltage characteristic are studied. At low levels of ionization the electron density is neglected with respect to the ion density. By coupling this simplification with correct scaling, it is possible to obtain analytic solutions. The resulting current-voltage characteristic reflects the rate of ionization as well as the ratio of the ion to the electron temperature. When this ratio is equal to unity, the ion and electron current fluxes saturate at the same rate. If this ratio is less than unity, the electron current flux saturates more slowly than the ion current flux. At higher levels of ionization the electron density can no longer be neglected with respect to the ion density and the problem is solved numerically. The current-voltage characteristic obtained in this case can be approximated analytically at small and large voltages. The expression which applies to small voltages agrees with the results of other double probe studies. (auth)

17153 PROBE DESIGN FOR ORBIT-LIMITED CURRENT COLLECTION. Laframboise, J. G. (Physics Department, York University, Toronto, Canada); Parker, L. W. Phys. Fluids 16: No. 5, 629-636 (May 1973).

A new type of electrostatic probe design is proposed, which should permit temperature and density measurements for both ions and electrons from the accelerated current regions of the probe characteristics. Ion temperature measurements, in particular, have been difficult to obtain using standard probe techniques. The method is based on the use of one of a family of nonspherical probe geometries which can be operated as if they were spheres collecting orbit-limited current. One such probe is a proposed multi-electrode system having the advantage that the collector can be made much smaller than the usual spherical probe. The simultaneous use of this probe with a standard orbit-limited cylindrical probe would then enable the above measurements to be made. The multi-electrode probe may itself function as an orbit-limited collector of both the spherical and cylindrical types, with different bias strategies on its electrodes for the two cases. The proposed probe operation is theoretically justified by rederiving the usual orbit-limited current expressions for spheres and circular cylinders, without making any assumption regarding particle angular momentum conservation. The expressions are thereby shown to apply to a wider variety of probe shapes, including: (a) any convex cylinder, (b) any "sufficiently convex" three-dimensional collector (for example prolate and oblate spheroids having major to minor axis ratios up to 1.653 and 2.537, respectively), and (c) the proposed multi-electrode design. Some aspects of probe use in flowing plasmas and in magnetic fields are also discussed. (auth)

17154 ENERGETIC ION BEAM SOURCE AND FREE-STREAM BEAM DIAGNOSTIC TECHNIQUES. Stenzel, R. L.; Ripin, B. H. (Department of Physics, University of California, Los Angeles, California 90024). Rev. Sci. Instrum. 44: No. 5, 617-621(May 1973).

A steady state, dc discharge, electrostatically focused ion beam source with permanent magnet multipole confinement is described. The ion beam is low density, $n_b \sim 10^8$ cm^{-3}, low divergence, $\theta \sim 1°$, energetic, $V_b \leq 5$ kV, and is suitable for investigating ion beam-plasma interactions. Ion beam speed and species are determined either by modulating the beam and analyzing the resulting free-streaming perturbations or by a pulse and time-of-flight technique. The amplitude of the free-streaming signal is enhanced in the electron cyclotron harmonic passbands due to the decreased dielectric function of the background plasma. Two beam-plasma instabilities, the electron cyclotron drift instability, and an instability at the lower hybrid frequency are observed using this ion source. (auth)

17155 TRANSIENT CURRENT OVERSHOOT TO ELECTROSTATIC PROBES IN CONTINUUM, SLIGHTLY IONIZED PLASMAS. Cohen, Ira M. (The Towne School of Civil and Mechanical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania 19174). Phys. Fluids 16: No. 5, 700-701 (May 1973).

A spherical probe is subjected to a potential ramp with rise time of the order of the electron diffusion time, after which, the final potential is maintained constant. The electron current overshoots its final value by an amount proportional to the electron conductivity. (auth)

17156 EFFECT OF A SHEATH ON THE FIELDS OF A PROBE IN A HOT MAGNETIZED PLASMA. Singh, N. (Department of Electrical Engineering, Indian Institute of Technology, Kanpur-16 U.P., India). Phys. Fluids 16: No. 5, 698-699 (May 1973).

A probe excites two waves, a slow and a fast wave in a hot magnetized plasma when $\omega < \omega_p$ and $\omega_c \gg \omega_p$. These waves propagate only within a cone of half-cone angle $\sin^{-1}(\omega/\omega_p)$. It is found that the sheath around the probe effectively attenuates the two waves and the slow wave is attenuated more than the fast one. (auth)

17157 COMMENT ON "CALIBRATION PROCEDURE TO CORRECT FOR THE EFFECT OF DIELECTRIC CONTAINERS IN MICROWAVE PLASMA DENSITY MEASUREMENTS". Schulz-DuBois, E. O. (IBM Zurich Research Laboratory, 8803 Rüschlikon, Switzerland). J. Appl. Phys. 44: No. 5, 2411-2411 (May 1973).

In a recent issue of this journal Wellenstein, Frommhold, and Robertson identified two reasons for systematic error in microwave electron density measurements and described a calibration procedure to eliminate the error. In this paper, use of a polar gas for calibration purposes is recommended and the choice of suitable cavity modes for this measurement technique is discussed. (auth)

Kinetics (General)

Refer also to abstract 16399.

17158 (EUR-CEA-FC-689-TR) RADIAL DISTRIBUTION OF THE CHARGE-EXCHANGE ATOM FLUX IN THE PLASMA OF THE TOKAMAK 4. Petrov, M. P. Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 17: No. 2, 110-113(1973). 10p. (In French). Dep. NTIS (U. S. Sales Only) $3.00.

The atom flux associated with the charge exchange of trapped ions was analyzed with respect to energy by inclining the axis of a 5-channel atom analyzer upward and downward in relation to the equatorial plane of the chamber. The radial distributions of the deuterium atom flux obtained in this way have symmetrical characteristics in a ±5-cm range about the small radius of the torus. The flux of the high-energy atoms decreases more rapidly at the periphery of the plasma with higher energies. The symmetry is violated when the axis of the analyzer is shifted from the equatorial plane by more than 10 cm, and the atom flux having $E \geq 1.3$ keV begins to increase again. The deviation from axial symmetry of the atom flux distribution is due to the penetration of atoms at the plasma periphery. The symmetrical character of the atom flux distribution from the internal zone of a 10-cm diameter plasma indicates that the distribution has a Maxwellian nature and that the ion temperature distribution is symmetrical and axial. (FR)

17159 (LA-5149) SOME FACTORS BEARING ON THE DECAY AND REVERSAL OF THE PLASMA CURRENT IN Z PINCHES. Boicourt, G. P. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 2p. Dep. NTIS $4.00.

The decay and reversal of currents in Z-pinch equivalent circuits are examined. It is shown that the physically observed effects do not require special plasma properties for their explanation because they are the normal behavior of the electrical circuit. (auth)

17160 PROSPECTS FOR FUSION RESEARCH IN BRITAIN. Marshall, W. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 243: No. 5407, 384-388(15 Jun 1973).

A review is presented under the following headings: history; recent progress; present programme; future prospects; programme review; and increasing involvement. It is emphasized that, although more money is to be spent in Britain on fusion research during the next few years, in the longer term international collaboration, for example within Europe, will become increasingly important. (UK)

17161 NORMAL DOPPLER-SHIFTED CYCLOTRON RADIATION FROM A COLD PLASMA. Singh, R. P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Planet. Space Sci.; 21: No. 7, 1268-1269(Jul 1973).

It is shown that the normal Doppler-shifted cyclotron radiation in the presence of a cold plasma at frequencies greater than the

electron cyclotron frequency in the ordinary mode is possible. The radiated power depends on the plasma parameters and the particle energy. It appears that the normal Doppler shifted cyclotron radiation can explain generated frequencies which are even greater than electron gyrofrequency. (UK)

17162 THEORETICAL AND NUMERICAL APPROACHES TO TURBULENCE-DOMINATED THETA PINCHES. Liewer, P. E. C. College Park, MD; Univ. of Maryland (1972). 197p. University Microfilms Order No. 73-17,042.

Thesis (Ph. D.).

Magnetic pulse propagation in a turbulent plasma was studied both theoretically and numerically to better understand experiments such as the theta pinch at the University of Maryland. Analytic and numerical calculations were done on the generally neglected lower hybrid drift instabilities which showed these modes to be important in a number of magnetic pulse experiments. Theoretical predictions of average heating rates, resistivity and fluctuating field levels due to these instabilities agreed well with the experimental results in three such experiments. A set of fluid equations were derived which included the effects of turbulence due to the lower hybrid and other unstable modes self-consistently, through transport terms which depend on the unstable mode and which evolve in time as the macroscopic fluid variables evolve. These fluid equations were integrated numerically using a recently developed algorithm that eliminates some important numerical problems present in earlier codes. The code was tested and then applied to two theta pinch experiments where turbulence was thought to play a dominant role. The results of the code agreed well both quantitatively and qualitatively with theta pinch experiments with no initial bias fields, and fairly small pulsed fields. Agreement was found with magnetic field and density profiles and with pulse penetration times. There was less agreement with theta experiments with bias fields and large pulsed fields, although there was agreement with the gross penetration times. Possible causes of the discrepancy are discussed. (Diss. Abstr. Int., B)

17163 EFFECT OF A HIGH FREQUENCY MAGNETIC FIELD ON PLASMA DIFFUSION IN A Q-MACHINE. Artsimovitch, L. L.; Ivanov, A. A.; Lukyantschuk, A. N.; Papernii, V. L.; Rusanov, V. D.; Sobolev, S. S. (Inst. of Atomic Energy, Moscow). Rev. Phys. Appl.; 8: No. 1, 49-52(Mar 1973).

Experimental results on the interaction of a high-frequency azimuthal magnetic field with drift and drift-dissipative oscillations in a Q machine are presented. Both the suppression of oscillations and a decrease in the transverse diffusion in the regime of a drift-dissipative instability are found. (FR)

17164 STUDY OF MOLECULAR DISSOCIATION IN AN OXYGEN PLASMA USING ELECTRON PARAMAGNETIC RESONANCE. Tchen, H.; Bediee, S. (Univ., Rennes, France). Compt. Rend., Ser. A, B; 276: No. 13, 519-522(26 Mar 1973). (In French).

The technique of electron paramagnetic resonance was used to study the molecular dissociation of oxygen in a plasma obtained by the microwave excitation (2450 MHz) of a gas current at pressures in the region of 1 torr. The effects of various experimental parameters such as the gas pressure and the microwave frequency energy on the dissociation rate were studied. (FR)

17165 PLASMA PHYSICS. 6th Czechoslovak Seminar, Liblice, Czechoslovakia, May 10–12, 1972. Prague; Ustav Fyziky Plasmatu CSAV (1972). 104p. (CONF-720588--).

The excitation and damping mechanism of waves and resonances in bounded magnetoactive media is studied, followed by an examination of parametric instabilities in gaseous plasmas. Absorption of the microwave energy in a magnetoactive plasma, the dynamics of strongly nonlinear beam-plasma interaction, and the momentum of quasi-monochromatic waves in a plasma are treated. Separate abstracts were prepared for five of the papers. The remaining two papers appeared previously in NSA 27: 21321 and 21439. (MOW)

For abstracts of individual papers see: 17200, 17211, and 17247–17249.

17166 INVESTIGATION OF SCATTERING MICROWAVES IN A PLASMA-BEAM DISCHARGE. Kirdyashev, K. P.; Zaykina, A. N. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 17: No. 9, 1491-1496(Sep 1972).

Translated from Radiotekh. Elektron.; 17: No. 9, 1873-1879(Sep 1972).

The field of a scattered wave in a plasma–beam discharge is investigated. The corresponding scattering cross section considerably exceeds the cross section of scattering on thermal fluctuations. The distribution of the intensity and fluctuation of the amplitude of the scattered wave corresponds to multiple scattering along the plasma column. The spectrum of scattering is determined by the perturbations in plasma density of the order of the wavelength of the probing wave; the high-frequency components in the spectrum of plasma oscillations correspond to those perturbations. (auth)

Kinetics (Experimental)

17167 MEASUREMENTS OF MAGNETIZED RARE GAS AFTERGLOW PLASMAS IN THE FREQUENCY RANGE 200 TO 1500 MHz. Dutt, T. L. (Polytechnic, London). J. Phys., B (London); 6: No. 6, 1129-1138(Jun 1973).

The change in the signal absorptions by rare gas afterglow plasmas as a dc magnetic field is varied in the range 0 to 400 G is studied in the frequency range 200 to 1500 MHz. The measurements are made using large aluminum cavities excited in the TM_{OmO} family of modes with a uniform dc magnetic field, B, applied along the direction of the alternating electric field. Signal absorptions are observed to occur, B = 0, at several successive times during the afterglow for signal frequency, f_M, when the pulsed plasma is excited by means of an 8 ms pulse of high frequency energy at 54 MHz. The absorptions get smaller as the magnetic field is increased slowly in magnitude, and disappear, in turn, for certain critical values of field, B_{crit}. Plots of f_M against B_{crit} fall on straight lines having almost integrally related slopes, the lowest slope having a value close to 2.80×10^6 Hz G^{-1} in magnitude. The phenomena are believed to be explicable in terms of the oscillations of a low energy gas of electron pairs, which break up at critical values of B. The plasma oscillations of a free electron gas are also briefly discussed. (auth)

17168 DIFFUSION OF A PLASMA WITH A SMALL DIELECTRIC CONSTANT IN THE DC OCTOPOLE. Tamano, Teruo; Prater, Ronald; Ohkawa, Tihiro (Gulf General Atomic Company, San Diego, California 92112). Phys. Rev. Lett. 30: No. 10, 431-434 (5 Mar 1973).

A new type of diffusion is observed. The observed dependences and magnitude of the diffusion coefficient are consistent with the theory of "classical" diffusion due to thermal equilibrium fluctuations for closed line configurations. The experimental results with the toroidal field are essentially the same as those without the toroidal field. The shear may be ineffective in modifying the diffusion rate because of the short perpendicular diffusion damping time compared with the parallel phase mixing time. (auth)

17169 EXPERIMENTAL OBSERVATION OF THE HIGH-DENSITY PLASMA-BEAM FORMATION BY CONTINUOUS-FLOW Z PINCH. Dah Yu Cheng, Wang, P. (Univ. of Santa Clara, CA). Nucl. Fusion; 13: No. 3, 458-461(Jun 1973).

A continuous-flow z-pinch plasma gun is described. A laser interferometer was used to photograph the plasma convergence. Time sequential pictures are described. The possibility of magnetic field annihilation is briefly discussed. (MOW)

17170 LINESHAPE OF STABLE ELECTROSTATIC FLUCTUATIONS IN A BEAM PLASMA SYSTEM. Walsh, J. E.; Conrad, J. R.; Diaz, C. J. (Dartmouth College, Hanover, New Hampshire 03755). Phys. Fluids 16: No. 5, 716-718 (May 1973).

The stable electrostatic fluctuations in a cylindrical magnetized beam plasma system show a triplet structure. The position and relative height of the peaks are directly related to the linearized dispersion relation. (auth)

17171 TIME-RESOLVED MEASUREMENT OF AN ELECTRON-BEAM DISTRIBUTION FUNCTION. Chang, J.; Swain, D. W.; Mix, L. P. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 44: No. 5, 2113-2114 (May 1973).

We have developed a technique for measuring the electron-beam distribution function as it evolves in phase space. Data illustrating the successful use of this technique are presented. Transit time and other effects which can cause errors using this technique are discussed. (auth)

Kinetics (Theoretical)

17172 (COO-3632-10) SCATTERING IN A STABLE BEAM-PLASMA SYSTEM. Diaz, C. J.; Conrad, J. R.; Walsh, J. E. (Dartmouth Coll., Hanover, N. H.). 1973. Contract AT(11-1)-3632. 23p. Dep. NTIS $3.25.

A Fokker-Planck equation is used to describe the random walk of the particles in stable electron-beam-driven fluctuations. The resulting kinetic equation is a bounded version of the Balescu–Lenard equation. The ion velocity distribution relaxation rates calculated on the basis of this equation exhibit a resonant structure for velocities near synchronism with the phase velocities of the modes predicted by the dispersion relation. (auth)

17173 (COO-3632-11) NONLINEAR CONTROL OF TURBULENCE AND VELOCITY SPACE DIFFUSION IN BEAM-PLASMA SYSTEMS. Progress Report, September 14, 1972 – June 14, 1973. Walsh, J. E.; Conrad, J. R.; Diaz, C. J.; Freese, K. B.; Hoffman, G. L.; Layman, R.W. (Dartmouth Coll., Hanover, N. H.). 14 Jun 1973. Contract AT(11-1)-3632. 45p. Dep. NTIS $4.25.

Measurements of electron heating in a moderate-energy, low-density, beam – plasma system are presented. Stability of the system is discussed and relationships between the degree of initial instability and beam energy transfer to the target plasma are established. The average electron energy viewed as a function of increasing initial destabilization is found to pass through three stages. In the first, the spectrum of the excitations is narrow, the average energy is dominated by the beam, and there is little energy transfer to the plasma. In the second, the spectral distribution is broader, the average particle energy decreases, and more energy is transferred to the wave spectrum. In the third stage, the spectrum extends from cutoff to an appreciable fraction of the plasma frequency. The average electron energy increases as the beam energy transferred to the spectrum is redistributed among the particles. In this latter stage, a high-energy tail appears on the distribution. A correlation between the appearance of this tail and the excitation of electron plasma waves near the lower hybrid cutoff is established. (auth)

17174 (IPP-2/212) STATIONARY CONVECTION IN TOROIDAL PLASMA CONFIGURATIONS. Wobig, H. (Max-Planck Institut fuer Plasmaphysik, Garching (West Germany)). May 1973. 29p. Dep. NTIS (U. S. Sales Only) $3.50.

The mathematical structure of the two-fluid MHD equations including plasma – neutral interaction is investigated. An elliptic system is obtained for the plasma density and the electric potential. These equations exhibit a strong similarity to the hydrodynamic equations of thermal convection. The set of equations is applied to a toroidal magnetic field with and without shear and it is shown that magnetic irregularities may cause appreciable convection. (auth)

17175 (MATT-896) BPERP, BSLANT, AND GLOBE: OPTIMIZED CODES FOR THE SIMULATION OF PLASMAS IN A STATIC UNIFORM MAGNETIC FIELD. Rosen, B.; Okuda, H.; Di Massa, L. G. (Princeton Univ., N. J. Plasma Physics Lab). Jun 1972. Contract AT(11-1)-3073. 14p. Dep. NTIS $3.00.

A description of optimized computer codes for the simulation of plasmas subject to a uniform, external, static magnetic field is given. The codes are of the particle-pushing variety. The optimization of the programs is traced through various steps including several phases of machine language coding. A brief review of the leap-frog algorithm for particle-pushing is included. The time required, per particle, per iteration, in 2 and $2\frac{1}{2}$ D simulations using an IBM 360/91 was 20 μsec and 27 μsec respectively in the most efficient versions of the code. This included time for the field calculations on a 32×32 grid. (auth)

17176 (UCSD-34-P-85-16) THEORETICAL PLASMA PHYSICS RESEARCH. Progress Report, 1972-73. Thompson, W. B. (California Univ., La Jolla, San Diego). 27 Jun 1973. Contract AT(04-3)-34. 619p. Dep. NTIS $33.00.

This report includes new results on neoclassical and two-dimensional diffusion, on beam-induced instabilities, and on plasma wave resonance of interest in rf heating, as well as studies in kinetic theory and the interaction of plasma and radiation. (auth)

17177 VARIATIONAL PRINCIPLE FOR AN INVISCID, PERFECT, MAGNETIZED PLASMA. Ito, H. (Osaka Univ., Suita, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 5, 1442-1450(Nov 1972).

A variational calculation for the motion of a compressible, inviscid, magnetized plasma with infinite conductivity is presented. The model for the calculation is essentially based on a theory of two fluids consisting of ions and electrons of the same number. For the mean velocity of these two components, the usual magnetohydrodynamic equation of motion, is obtained. The equation of the current variation is derived for their relative velocity. From this calculus of variation using an appropriate Lagrangian, a generalized London equation in the theory of superconductors is directly obtained. The behavior of the vorticity of this magnetized fluid is the same as that of usual ideal fluids. The frozen-in condition of the magnetic field into the plasma with infinite conductivity is closely related to the vorticity condition. (auth)

17178 THEORETICAL STUDY OF THE EFFECTS OF ION MOTION ON SPECTRAL LINES IN PLASMAS. 1. Neutral Helium Lines. Lee, R. W. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 6: No. 6, 1044-1059(Jun 1973).

A theory of spectral line broadening in plasmas which accounts for the ion dynamic broadening is reviewed and modifications are made to achieve a form which is amenable to calculation. The calculational procedure is discussed. The results are compared with other theories of spectral line broadening in plasmas and experimental data. A brief discussion is given of the alternative methods used to introduce ion dynamics into line broadening formalisms. (auth)

17179 THEORETICAL STUDY OF THE EFFECTS OF ION MOTION ON SPECTRAL LINES IN PLASMAS. 2. Hydrogen – H_β. Lee, R. W. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 6: No. 6, 1060-1069(Jun 1973).

Calculations of the plasma broadened H_β profile including ion dynamics are presented. The effects on the line profile of the random phase approximation for the plasma subsystem is examined. Comparisons are made of theory and experiment and a discussion of the asymmetry of the profiles is given. (auth)

17180 TRANSPORT PROPERTIES OF TWO-TEMPERATURE PARTIALLY IONIZED ARGON. Miller, E. J.; S. I. Sandler (Department of Chemical Engineering, University of Delaware, Newark, Delaware 19711). Phys. Fluids 16: No. 4, 491-494 (Apr 1973).

Calculations are presented for the transport properties of a two-temperature argon plasma based on the Chapman-Enskog and perturbed-Lorentzian solutions of the Boltzmann equations. The convergence problems known to exist in the Chapman-Enskog solution for the properties of a one-temperature argon plasma also occur here; this difficulty is removed by using the perturbed Lorentzian solution at low and moderate degrees of ionization. Also, it is found that the lowest order perturbed Lorentzian and Chapman-Enskog approximate solutions provide upper and lower bounds to the actual solution at low and moderate degrees of ionization. Finally, owing to the Ramsauer minimum in the electron-atom cross section, the electrical conductivity of the two-temperature argon plasma is found to decrease with increasing electron temperature (at fixed heavy particle temperature and electron density) at low degrees of ionization, and increase with increasing electron temperature at higher degrees of ionization. (auth)

17181 EFFECT OF INDUCED AXIAL ELECTRIC FIELD ON A RELATIVISTIC ELECTRON BEAM PULSE PROPAGATING THROUGH A PLASMA. Swain, David W. (Sandia Laboratories, Albuquerque, New Mexico 87115). Phys. Fluids 16: No. 4, 569-571 (Apr 1973).

If a plasma exhibits anomalous conductivity, the shape of a high-current beam pulse injected into the plasma may be strongly affected after propagating less than one-pulse length. (auth)

17182 CURRENT-DRIVEN ION ACOUSTIC INSTABILITY IN A COLLISIONAL PLASMA. Sundaram, A. K.; Kaw, P. K. (Physical Research Laboratory, Navrangpura, Ahmedabad 9, India). Phys. Fluids 16: No. 4, 563-564 (Apr 1973).

An analytical investigation of the current driven ion wave instability in a collisional plasma, taking account of the background temperature variations, has been carried out. (auth)

17183 ENERGY-CONSERVING PLASMA SIMULATION ALGORITHMS. Langson, A. B. (Univ. of California, Livermore). J. Comput. Phys.; 12: No. 2, 247-268(Jun 1973).

Lewis has found algorithms for many-particle plasma simulation models in which there exists an exact energy constant in the limit of small time step. The requirements for energy conservation are examined here and relaxed from those given by Lewis, in that his prescription for the difference form of Poisson's equation is found not necessary. One may, therefore, choose the Poisson algorithm to satisfy other criteria. However, a connection is established between Lewis' difference equation, the interpolation method, and the accuracy of the Coulomb interparticle forces. Unlike the usual models, momentum is not conserved by these algorithms. Rough measures are given for the importance of this nonconservation in the simplest case of linear interpolation. Another example uses spline interpolation to obtain smoother and more accurate fields and better momentum conservation. (auth)

17184 IMPROVEMENTS IN THE RELAXATION THEORY OF SPECTRAL-LINE BROADENING IN PLASMAS. Whalen, J. E. Gainesville, FL; Univ. of Florida (1972). 174p. University Microfilms Order No. 73-15,606.

Thesis (Ph.D.).

Several improvements in previous treatments of the relaxation theory of spectral-line broadening in a plasma are presented. (1) To second order in the coupling constant, the theory is extended to include ion-field effects in the atomic Boltzmann factors and the electron collision operators. (2) The theory is extended to include full Coulomb interaction between the radiating atoms and the perturbing electrons. The effect of using a strong collision cutoff on the theoretical computations is examined. (4) The effects of electron symmetry are introduced through an effective Boltzmann distribution. (5) A static wing formula is developed. Computations

are presented for the Lyman-alpha transition in hydrogen and ionized helium. For frequency separations from the line center greater than 10 times the ion plasma frequency, the calculated profiles for the Lyman-alpha line agree quite well with the experimental data. However, there are noticeable differences in the theoretical results in the line center; these discrepancies are examined. From the behavior of the Lyman-alpha profile, when the full Coulomb interaction is used, it is concluded that higher-order terms in the coupling constant are required to properly describe the intensity in the line center. An explicit expression is derived for a typical higher-order term in the perturbation expansion and an upper bound is obtained for this term. It is shown that the perturbation expansion does indeed break down for small frequency separations corresponding to the line center. The calculated results using the static wing formula are compared with the experimental data for frequency separations greater than the electron plasma frequency. This theory provides an inexpensive means for computing wing profiles which may be useful to experimentalists and astrophysicists. (Diss. Abstr. Int., B)

17185 POLARIZATION MATRIX FOR A RELATIVISTIC QUANTUM PLASMA IN AN EXTERNAL MAGNETIC FIELD. Cover, R. A. Waltham MA; Brandeis Univ. (1973). 166p. University Microfilms Order No. 73-15,434.

Thesis (Ph.D.).

The relationship of the polarization matrix to the dielectric tensor is derived. The expression for the polarization matrix in terms of one-particle Green's functions is derived using the method of functional differentiation. The Green's function for a particle in a magnetic field is derived and its translational noninvariance and gauge-dependence is shown to be isolated in a phase factor that cancels out in the calculation of the polarization matrix. Problems which arise in the symmetry of the matrix are discussed. The matrix can be separated into a particle part, a positron part which is ignored, and a vacuum part. Because of problems connected with perpendicular propagation, only the parallel propagation case was considered in subsequent calculations. With reference to the particle part, the static longitudinal susceptibility and magnetic polarizability were calculated and the non-relativistic limits were compared with published results. The longitudinal and transverse elements of the matrix for the dynamic, spatially uniform case were calculated, which, when equated to ω^2, represented the dispersion relation for the matrix. With respect to the vacuum part, the static longitudinal element gave a result which could be rendered finite by the usual subtraction procedures. However, these procedures did not work in the case of the transverse element. The same results obtained in the dynamic, spatially uniform limit. Finally, the complete, unregularized longitudinal and transverse elements were calculated. In an appendix, the problem of perpendicular propagation was examined; in a second appendix the general form of the matrix elements for arbitrary k and ω is derived. (Diss. Abstr. Int., B.)

17186 THEORY OF THE ANOMALOUS SKIN EFFECT IN A PLASMA WITH A DIFFUSE BOUNDARY. Dikman, S. M.; Meierovich, B. E. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1653-1671(May 1973). (In Russian).

A theory is developed of the anomalous skin effect in a plasma with a diffuse boundary located in a magnetic field. Penetration of an electromagnetic wave into a finite size plasma layer is also investigated. Final solutions are obtained for cases when the electron concentration outside the plasma drops exponentially or according to a power law. (auth)

17187 THEORY OF IONIZATION EQUILIBRIUM IN DENSE PLASMAS. Ebeling, W.; Saendig, R. (Univ., Rostock, Ger.). Ann. Phys. (Leipzig); 28: No. 4, 289-305(1973).

The Saha equation for the ionization equilibrium in plasmas is analyzed. Especially the balance between the effect of bound states (mass action constant) and the effect of free states (lowering of the ionization energy) is investigated. The lowering of the ionization energy is represented as an expansion with respect to the density. It is shown that the coefficients of this expansion and the mass action constant are connected with the known quantum statistical virial coefficients. The question of introducing the energy levels of a screened Coulomb potential is investigated. Several possibilities for the choice of the weight factor in the mass action constant are discussed. In the case of higher densities Padé approximations for the ionization energy are constructed. The existence of instabilities of the Norman–Starostin type is discussed. (auth)

17188 SLOWING DOWN OF RELATIVISTIC ELECTRONS IN PLASMA. Kammash, T.; Galbraith, D. L. (Univ. of Michigan, Ann Arbor). Nucl. Fusion; 13: No. 3, 464-468(Jun 1973).

A relativistically invariant expression is obtained for the slowing down of high-energy electrons in a Maxwellian plasma. For electrons colliding with electrons, the results are extended by expansion in the parameter (kT/mc^2) to electrons with energies up to 10 MeV. (MOW)

17189 STEADY-STATE SOLUTIONS OF THE NEO-CLASSICAL TRANSPORT EQUATIONS. MacMahon, A. B.; Ware, A. A. (Univ. of Texas, Austin). Nucl. Fusion; 13: No. 3, 413-421(Jun 1973).

The neoclassical transport equations of Rosenbluth, Hazeltine and Hinton were solved for steady-state conditions in which the trapped-particle pinch effect balances the particle diffusion. By using the banana-regime coefficients at all radii (this introduces only small errors for steady-state solutions) and the simplest possible boundary conditions, the solutions for a given aspect ratio are found to depend on the single parameter $\alpha^2 = a^2\,\omega_{pi}^2/c^2$, where a is the minor tube radius and ω_{pi} the ion plasma frequency for the central density. The results indicate (i) a permanent skin current at intermediate values of α^2, (ii) the importance of the trapped-particle Ettingshausen effect, (iii) the relative unimportance in the steady state of trapped-particle effects on the current and (iv) almost constant $\bar{\beta}$ and $\tau_E c^2/\pi\bar{\sigma}a^2$. Item (iv) agrees with the T-3 experimental results and the numerical values show no large anomaly in the electron thermal conductivity other than that caused by the increased collision frequency which is indicated by the observed average electrical conductivity $\bar{\sigma}$. (auth)

17190 APPLICATION OF THE KUBO-MORI THEORY TO THE LINE SHAPE OF PLASMA OSCILLATIONS. Walsh, J. E. (Department of Physics and Astronomy, Dartmouth College, Hanover, New Hampshire 03755). Phys. Fluids 16: No. 5, 702-703 (May 1973).

The Kubo–Mori modified theory of Brownian motion is applied to the longitudinal oscillation problem. It is found that the dispersion and friction determined by this theory are equivalent to ordinary plasma dispersion. (auth)

17191 CROSSOVER FREQUENCIES IN MULTICOMPONENT PLASMA. Uberoi, C. (Department of Applied Mathematics, Indian Institute of Science. Bangalore-12, India). Phys. Fluids 16: No. 5, 704-705 (May 1973).

A method for finding the roots of the equation D=O in a multicomponent plasma with positive and negative ion species is given. The use of dispersion diagrams (ω–k diagrams) for right– and left–circularly polarized waves is made to locate these roots in pass or stop bands. (auth)

Production

Refer also to abstract 17836.

17192 (FRNC-TH-364) STUDY OF RADIATIONS IN PLASMAS Piar, G. (Rouen Univ. (France). Faculte des Sciences). 1972. 223p. (In French). Dep. NTIS (U. S. Sales Only) $13.25.

Thesis.

A spectroscopic study was initially carried out on the limiting layers developing in the vicinity of a plane metallic wall situated in an argon plasma flow. This investigation was carried out in a specially constructed plasma wind tunnel. In this way, the electron temperature and density were determined from the intensities of the emission lines at atmospheric pressure and at low pressure. It was shown that the ion–electron recombination rate was principally a function of the depopulation of the resonance levels. An attempt was made to interpret the electron-temperature results in terms of the emission of Auger electrons with high energies. The high electron density observed near to the wall agrees with collisionless ion sheath theories. The second part of this thesis is devoted to a laser–matter (deuterium) interaction experiment. This experiment enabled the existence of nuclear fusion reactions associated with the creation of the plasma to be established The effects of impurities (nitrogen and oxygen) present in the deuterium and of ionized volume inhomogeneities on plasma emission and the measurement of the electron temperature were studied. Investigations of the scattering of laser radiation from the plasma enabled stimulated effects and nonlinear propagation phenomena at the laser frequency, as well as nonlinear effects at double this frequency, to be studied. (FR)

17193 (FRNC-TH-365) IONIZATION KINETICS OF AN ARGON PLASMA CREATED BY A SHOCK WAVE. Larcher, G. (Rouen Univ. (France). Faculte des Sciences). 1972. 184p. (In French). Dep. NTIS (U. S. Sales Only) $11.25.

Thesis.

Some preliminary calculations concerning the thermodynamic parameters of the gas when subjected to the shock wave are presented. A description is given of the shock tube and the optical methods used in the measurements (strioscopy and spectrophotometry) for determining the velocity of the shock wave, the ob-

servation time, the relaxation time, and the electron temperature and density at equilibrium. The results obtained in measurements of the radiation energy losses in the cooling zone were studied. The ionization kinetics near to equilibrium obtained by measuring the intensity of the continuously emitted background were compared with the calculated behavior of the electron density, the existence of ionization processes due to electron–atom collisions in the plasma out of thermodynamic equilibrium being admitted. The method used to determine the electron density near to the shock front is outlined. In this method the power transmitted by a millimeter wave is measured. The results obtained in calculations of atom–atom collision cross sections are given. (119 references) (FR)

17194 (SC-DC-721508) PARAMETRIC CORRELATIONS IN ENERGETIC LASER PLASMAS. Olsen, J. N.; Kuswa, G. W.; Jones, E. D. (Sandia Labs., Albuquerque, N. Mex.). 1972. 37p. (CONF-721132–10). Dep. NTIS $4.00.

From plasma physics meeting of the American Physical Society; Monterey, California, USA (13 Nov 1972).

The analysis of LiH and LiD, nanosecond-created, laser plasmas reveals correlations between the various parameters of each plasma event. Relationships are found involving the energy spectra of the ion species, the target reflectivity, neutron and hard x-ray production, the electron temperature and the input laser energy. Ion expansion spectra of nonthermal origin are observed under the condition of high target reflectivity. High target reflectance is correlated to neutron and hard x-ray production as well as decreased electron thermal content for laser energies of 18 to 70J. The ion expansion spectra are obtained with mass and charge separation by the parallel electric and magnetic fields of a Thomson parabola ion analyzer. A novel feature of this device is the conversion of the analyzed ion beam to a visible image via an electron multiplier array, providing complete information on a single shot basis. The Nd^{+3} glass laser used in these experiments delivers up to 70J to the target in 2.5-ns (FWHM) pulses from a four-amplifier system. Isolation and protection of the smaller amplifiers from amplified target feedback is accomplished by insertion of a pulsed Faraday rotator between the second and third amplifiers. (auth)

17195 (SC-DC-721536) GEOMETRICAL EFFECTS ON THE SOURCE OF SPONTANEOUS LASER-GENERATED MAGNETIC FIELDS. Wright, T. P.; Widner, M. M. (Sandia Labs., Albuquerque, N. Mex.). 1972. 8p. (CONF-721132–11). Dep. NTIS $3.00.

From plasma physics meeting of the American Physical Society; Monterey, California, USA (13 Nov 1972).

The effect of laser–target geometry on the self-generated magnetic fields is discussed. The production and properties of the self-generated fields are described. (MOW)

17196 (SLA-73-5352) LASER FUSION. Palmer, R. E. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 7p. Dep. NTIS $3.00.

The application of lasers for sustaining controlled fusion is discussed. The basic conditions necessary to achieve fusion are described along with two other possible techniques, namely, electromagnetic confinement and electron beam heating. The principal problems facing fusion research and the future of laser fusion are described. (MOW)

17197 PRE-IONIZATION AND PRE-HEAT CONDITIONS FOR A COMPACT TOROIDAL PLASMA EXPERIMENT IN THE MILLITORR PRESSURE RANGE. Sand, F.; Waelbroeck, F.; Wadmann, G. (Kernforschungsanlage, Juelich, Ger.). Nucl. Fusion; 13: No. 3, 373-380(Jun 1973).

The production of a highly ionized deuterium plasma at initial gas pressures of 0.5 to 2 mtorr was investigated in a compact toroidal geometry (major radius of the torus vessel 20 cm, minor radius 10 cm). The gas, pre-ionized by a capacitively coupled rf-discharge, is further ionized (pre-heated) by toroidal and poloidal plasma currents which are induced by the discharge of a condenser bank (7.5 kJ maximum energy) into a helical coil system wound around the torus. At the end of the ionization phase, the current in the coil is crowbarred. Radial plasma density profiles are measured by using a movable 4-mm microwave probe. The plasma current, its energy, and the toroidal and poloidal magnetic field distributions are deduced from magnetic measurements, and the electron temperature from the D_β-line-to-continuum-light-intensity ratio. At the low initial gas pressures studied here, the plasma formation occurs when the toroidal electric field amplitude on the torus axis lies below a critical value (<6V/cm·mtorr). Using a programmed auxiliary perpendicular magnetic field, a plasma which is both highly ionized and well detached from the walls of the torus is obtained. Plasma equilibrium can be maintained during the time of observation (up to ≈40 μs after crowbar). Electron densities greater than 6×10^{13} cm^{-3} (cutoff density for 4-mm waves), a degree of ionization higher than 60%, and electron temperatures of 5 eV are reached starting from a pressure of 1 mtorr D_2. The toroidal plasma current and the toroidal magnetic field are, respectively, 7 kA and 0.45 kG at the time of crowbar. The measured density and magnetic field profiles indicate that the magnetic axis lies significantly off the axis of the torus vessel. (auth)

17198 THERMAL-CONDUCTION LIMITATIONS IN LASER FUSION. Bickerton, R. J. (Culham Lab., Abingdon, Eng.). Nucl. Fusion; 13: No. 3, 457-458(Jun 1973).

The first region of a laser plasma is the outer low-density corona. The second region is the denser, ablating plasma heated by thermal conduction from the corona. The third region is the core which initially is compressed as near isentropically as possible. In the second region, where thermal conduction is a dominant process, conditions may become so extreme that the simple concept of thermal conductivity becomes invalid. The resultant limitations to the energy flux are discussed. (MOW)

17199 HF DISCHARGES SUSTAINED IN A RESONANCE CAVITY OR IN A RESONANT PLASMA. Bloyet, E.; Leprince, P.; Milleon, H. (Paris Univ., Orsay, France). J. Phys. (Paris); 34: No. 2, 185-195(Feb 1973). (In French).

A linear boundered plasma theory can be used to study the high-power behavior of a resonantly sustained plasma inside a cylindrical cavity. The plasma can either be sustained in one of its plasma resonant states or in one of its cavity resonant states; densities above the critical density ($\omega_p > \omega$, where ω is the angular frequency of the hf field and ω_p is the electron plasma frequency) can be obtained. A theoretical model based on the energy balance of the electron gas is established. In a second part, a column plasma is created by exciting axially symmetric or dipolar plasma modes. Initially the discharge is created inside a cavity; it then extends appreciably outside the cavity. This allows the surface wave to propagate a greater distance and in turn allows the process to be repeated until the wave power has been attenuated. In this way a plasma column is obtained. Plasma densities 1000 times greater than the critical density can easily be produced by exciting the axially symmetric mode. (FR)

17200 EXPERIMENTAL STUDY OF THE INTERACTION BETWEEN A LASER/SOLID CREATED PLASMA AND A MAGNETIC FIELD. Fabre, E.; Stenz, C.; Colburn, S. (Ecole Polytechnique, Paris). J. Phys. (Paris); 34: No. 4, 323-331(Apr 1973). (In French).

The confinement of a laser/solid created plasma in a magnetic field was studied. The experimental results demonstrate that the deceleration of the expansion is in agreement with a spherical model developed for a high-conductivity plasma. The temperature of the captured plasma is between 6 and 10 eV and is less than that attained during heating. The presences and sizes of the targets are the causes of particle losses at high energies. The confinement achieved is limited by the presence of neutral atoms coming off the target after it has cooled the captured plasma. (FR)

17201 ION-EXPANSION ENERGY SPECTRA CORRELATED TO LASER PLASMA PARAMETERS. Olsen, J. N.; Kuswa, G. W.; Jones, E. D. (Sandia Laboratories, Albuquerque, New Mexico 87115). J. Appl. Phys. 44: No. 5, 2275-2283 (May 1973).

The analysis of LiH and LiD nanosecond-created laser plasmas reveals correlations between the various parameters of each plasma event. Relationships are found involving the energy spectra of the ion species, the target reflectivity, neutron production, hard and soft x-ray emission, the electron temperature, and the input laser energy. Ion-expansion spectra of nonthermal origin are observed under the condition of high target reflectivity. High target reflectance is correlated to neutron and hard x-ray production as well as an apparent decrease in electron thermal content for laser energies of 18–70 J. The ion-expansion spectra are obtained with mass and charge separation by the parallel electric and magnetic fields of a Thomson parabola ion analyzer. A novel feature of this device is the conversion of the analyzed ion beam to a visible image via an electron multiplier array, providing complete information on a single-shot basis. The Nd^{+3} glass laser used in these experiments delivers up to 70 J to the target in 2.5 nsec (FWHM) pulses from a four-amplifier system. Isolation and protection of the smaller amplifiers from amplified target feedback is accomplished by insertion of a pulsed Faraday rotator between the second and third amplifiers. (auth)

Stability

Refer also to abstract 17139.

17202 (CEA-CONF-2316) ENERGY PRINCIPLE FOR PLASMA STABILITY AGAINST LOW-FREQUENCY ELECTROSTATIC MOTIONS. Andreoletti, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 1p. (CONF-730446-1). Dep. NTIS $3.00.

Starting from the biadiabatic motion of a charged particle in a strong magnetic field, the equations governing the slow electrostatic motions of a collisionless plasma are obtained. The second order variation δ^2 of the total energy (it differs slightly from the expression derived by Rutherford and Frieman) is calculated, and then verified that it is in fact conserved by small motions. This functional δ^2 gives a sufficient variational condition for stability. By expanding the distribution function for high phase velocities with respect to drift velocities (long wavelengths), a Lagrangian formalism is established and it is shown that in this domain the variational condition derived from the energy is necessary and sufficient for stability. This result is derived for arbitrary magnetic fields and distribution functions, and it accounts for the slow interchange motions as well as the so called trapped-particle motions. The application to axisymmetric cases with locally Maxwellian distributions reproduces already known expressions. A domain is defined that is called "magnetodynamic limit:" the gradient operator ∇ is smaller by one order of magnitude in m/q (similarly to $(\partial/\partial t)$) with respect to the case of the adiabatic dynamics with zero order electric drift. It is in this domain that the biadiabatic motions, even if nonelectrostatic, give an energy principle identical with that of Kruskal and Oberman. This stability variational principle and the one obtained above become identical for the slow-interchange motions. (auth)

17203 (CEA-CONF-2317) LOCALIZED CRITERIA OF STABILITY IN MHD. Mercier, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 19p. (CONF-730446-2). Dep. NTIS (U. S. Sales Only) $3.00.

The study of MHD stability in plasmas with scalar pressure and infinite conductivity is carried out on the basis of the energy principle. In the case of toroidal plasmas, in spite of numerous studies, the region of complete stability is not yet perfectly known. Perturbations localized near a magnetic surface are discussed. One can distinguish between two classes of such perturbations: one of these classes leads to the usual localized criterion which has been extensively applied to a large number of configurations. The other class, called "ballooning"-type perturbation, does not always lead to an explicit form of criterion but some minimizations have to be carried out numerically. Near the magnetic axis, the two types of perturbations, though distinct, lead to the same results in any toroidal geometry. In axisymmetry (Tokomak-type) it is possible to obtain precise results which show that, away from the magnetic axis, the two criteria are different and any one of them may be more or less stringent according to the configuration considered. (auth)

17204 NONLINEAR THEORY OF THE MIRROR FLUTE INSTABILITY. Weng, C. I. Rochester, NY; Univ. of Rochester (1972). 95p. University Microfilms Order No. 73-14,839.

Thesis (Ph. D.).

The nonlinear small-amplitude behavior of a collisionless plasma is studied at the mirror flute instability threshold. A treatment assuming a "constant gravity" model of the mirror field predicts saturation of the m = 1 mode amplitude in disagreement with experiment. A model using nonconstant gravity yields the previous threshold mode and an upper damped mode. Nonlinear analysis shows the upper mode to be nonlinearly unstable. If the lower mode reaches sufficient amplitude it triggers the upper and is itself shut off. The resulting behavior is in general agreement with experiments. (Diss. Abstr. Int., B)

17205 OPTICAL SENSING AND ELECTRICAL FEEDBACK SYSTEM (ENGINEERING MATERIALS). (Princeton Univ., N. J.. Plasma Physics Lab.). (CAPE-2352).

2 drawings.

An optical sensing and electrical feedback system is described that will damp out the orbital motion of a particle levitated in a three-phase electric field. This eliminates the necessity of introducing a background gas for this purpose. (See also Rev. Sci. Instr., 43: 1093-4(Aug. 1972)). (auth)

17206 PARAMETRIC INSTABILITIES IN A PLASMA CONTAINING TWO TYPES OF IONS. Kitsenko, A. B.; Stepanov, K. N. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1606-1620(May 1973). (In Russian).

The stability is investigated of a homogeneous plasma that consists of electrons and of two types of ions and which is located in an alternating electric field with a frequency of the order of the ion cyclotron frequency. The relative velocity of the ions in the field in a direction perpendicular to the magnetic field is assumed to be smaller or on the order of the ion thermal velocity. Parametric excitation of longitudinal oscillations moving almost perpendicular to the magnetic field is considered. Oscillation excitation is due to relative motion of the ions. The oscillation increments are determined for frequencies of ion–ion hybrid resonance, ion cyclotron oscillations and ion–ion sound. (auth)

17207 NONLINEAR THEORY ON BEAM–PLASMA INSTABILITY. Krasovitskii, V. B. Zh. Eksp. Teor. Fiz.; 64: No. 5, 1597-1605(May 1973). (In Russian).

The possibility of radial focusing of a relativistic electron beam in a plasma under conditions of beam instability due to the reaction of the electromagnetic radiation on the beam is demonstrated. The radius of a focused (cold) beam and of a beam with a Maxwellian momentum distribution function is found from the condition of radial energy equilibrium. (auth)

17208 INVESTIGATION OF EQUILIBRIUM AND STABILITY OF SELF-COMPRESSED DISCHARGES IN AN OPTICALLY DENSE PLASMA. Aleksandrov, A. F.; Zosimov, V. V.; Rukhadze, A. A.; Savoskin, V. I.; Timofeev, I. B. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1568-1580(May 1973). (In Russian).

The region of existence and the main parameters are investigated of a high-current self-compressed opaque discharge produced by electric explosion of wires of various metals. It is found experimentally that an opaque equilibrium discharge with a homogeneous temperature exists in a rather narrow range of discharge current from ~100 to 130 to ~300 kA. The absolute value of the radiance temperature grows with increase of the discharge current and decrease of number of particles in the discharge. The characteristic sizes and electric characteristics of the discharge and also the radiation output in various spectral intervals and the energy balance are determined. It is shown that discharges with lengths considerably exceeding their diameter are subject to instabilities of the constriction and kink types. Their development increments which depend on the velocity of isothermal sound are also determined. The experimental results are compared with the theoretical calculations and satisfactory agreement is found. As radiation sources, the discharges studied possess about the same characteristics as the selective discharges in lithium or atmospheric discharges. (auth)

17209 ANISOTROPIC CYCLOTRON INSTABILITY IN AN INHOMOGENEOUS MAGNETIC FIELD. Timofeev, A. V. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 13: No. 3, 381-384 (Jun 1973).

Anisotropy in the energy distribution of ions leads to the buildup of oscillations with frequencies near the cyclotron resonance frequencies, $\omega \approx n\omega_i$. Oscillations with $\omega < n\omega_i$ are unstable, while those with $\omega > n\omega_i$ are damped, even in a nonequilibrium plasma. If the magnetic field is inhomogeneous, a region of oscillation build-up can coexist with a region of oscillation damping. In an inhomogeneous magnetic field, therefore, anisotropic cyclotron instability is possible only when the influence of the region of oscillation build-up, where $\omega_i > \omega/n$, is predominant. If the magnetic field varies monotonically, this requires fulfillment of the condition $(\eta_n/\omega_i^2 n_0)' > 0$. The prime in this expression denotes the derivative in the direction of the magnetic field, n_0 is the plasma density and $\eta_n = 2\pi \int_0^\infty dv_\perp v_\perp J_n^2 (k_\perp v_\perp/\omega_i) F_0(v_\perp)$, where $F_0(v_\perp)$ is the transverse velocity distribution function of the ions, $k_\perp$ is the transverse component of the wave vector and J_n is a Bessel function with index n. If the magnetic field has a minimum, there is no damping region for oscillations with $\omega = n\omega_{i\,min}$ and these oscillations therefore build up at the highest rate. (auth)

17210 CRITICAL β IN A TORUS WITH RECTANGULAR CROSS SECTION. Suzuki, Y. (Nagoya Univ., Japan). Nucl. Fusion; 13: No. 3, 369-372(Jun 1973).

A simple diffuse-boundary model is considered for magnetohydrodynamic equilibrium in an axisymmetric torus with rectangular cross section. The pressure balance equations are reduced from the expressions for eigenvalues of the equilibrium equation. The parameter β_p (ratio of plasma pressure to poloidal magnetic pressure) is closely related to the paramagnetism of the plasma and to geometrical factors. The condition of no reversed toroidal current gives the limitation on paramagnetism and β_p. The critical β_p becomes largest for square plasma cross section. (auth)

17211 THEORETICAL SITUATION WITH THE INVESTIGATIONS OF PARAMETRIC INSTABILITIES IN GASEOUS PLASMAS. Wallis, G.; Suender, D. (Zentralinstitut fuer Elektronenphysik, Berlin). pp 17-42 of Plasma Physics. Prague; Ustav Fyziky Plasmatu CSAV (1972).

From 6th seminar on plasma physics; Liblice, Czechoslovakia (10 May 1972). See CONF-720588--.

Some of the effects connected with parametric excitation and amplification of waves in gaseous plasmas, and of the correspond-

ing instabilities are outlined. Following a review of the mathematical background, parametric excitation within the framework of the "linear" theory is discussed, with reference to homogeneous unbounded plasma, inhomogeneous plasma, and bounded plasma. The nonlinear saturation of parametric instabilities is treated, and the possible application of results is examined. (IAA)

17212 NONLINEAR EVOLUTION OF THE DECAY INSTABILITY IN A PLASMA WITH COMPARABLE ELECTRON AND ION TEMPERATURES. Kruer, W. L.; Valeo, E. J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). Phys. Fluids 16: No. 5, 675-682 (May 1973).

The nonlinear evolution of the decay instability in a plasma driven by an externally imposed pump field oscillating near the electron plasma frequency is considered. For a plasma with comparable electron and ion temperatures and for weak pump fields, nonlinear Landau damping of electron plasma waves on the ions is the dominant nonlinearity. It is demonstrated that a one-dimensional wave kinetic equation describes the dominant interactions for spectral intensities whose characteristic angular width is small. This equation is solved numerically with the exact form for the matrix element which describes the coupling. An analytical solution is found for the spectral intensity in the limit in which the (small) spontaneous emission term is neglected. The plasma wave energies obtained both numerically and analytically are in good agreement. General characteristics of the plasma wave spectrum agree with observations in the ionosphere. The enhanced dissipation rate of the pump due to the presence of the fluctuations agrees with that observed in a laboratory experiment. (auth)

17213 DYNAMIC STABILIZATION OF PLASMAS BY MEANS OF A HIGH-FREQUENCY-MODULATED ELECTRON BEAM. Aghevli, R.; Rowe, J. E. (Electron Physics Laboratory, Department of Electrical and Computer Engineering, The University of Michigan, Ann Arbor, Michigan 48104). Phys. Fluids 16: No. 5, 686-691 (May 1973).

The stabilizing effects that a beam of longitudinally nonuniform density imposes on beam-plasma instabilities are investigated using a hydrodynamic model adapted for an infinite, one-dimensional beam-plasma system. The electron beam is characterized by either of two types of longitudinal inhomogeneity—square-wave or sinusoidal. The results, for the square-wave type of inhomogeneity, indicate a disappearance of the convective instabilities below a threshold frequency as well as a reduction in the growth rate for the remainder of the spectrum. Similar results are obtained for the case of a high-frequency sinusoidal pulsation of the beam density. Effects resulting from finite temperature plasma electrons are also discussed. (auth)

17214 FEEDBACK STABILIZATION OF AN ION-ACOUSTIC INSTABILITY. Boswell, R. W.; Christiansen, P. J. (Plasma Physics Group, School of Mathematical and Physical Sciences, University of Sussex, Sussex, England). Phys. Fluids 16: No. 5, 692-694 (May 1973).

A remote feedback technique has been employed to stabilize an ion-acoustic type of instability in a plasma with a low frequency density modulation. The plasma is unstable for certain values of n and dn/dr which occur during part of the period of the low frequency modulation. Agreement with the Van der Pol approach is good when the instability is allowed to saturate and the cross field diffusion is shown to decrease when the plasma is stabilized. (auth)

17215 OBSERVATIONS OF TWO-STREAM ION WAVE INSTABILITY. Christoffersen, G. B.; Prahm, L. P. (Physics Department, Danish Atomic Energy Commission, Research Establishment Risø, Roskilde, Denmark). Phys. Fluids 16: No. 5, 708-710 (May 1973).

A double-humped ion velocity distribution function is produced in a Q-machine cesium plasma. When the plasma becomes unstable, a growing wave amplitude and a characteristic change in the phase velocity of a grid-excited ion-acoustic wave are observed. (auth)

17216 ION-ION INSTABILITY INDUCED BY A.C. ELECTRIC FIELDS. Papadopoulos, Konstantinos (Naval Research Laboratory, Washington, D.C. 20390); McBride, John B. Phys. Fluids 16: No. 5, 711-713 (May 1973).

The presence of flow frequency fields in a plasma substantially modifies the marginal stability condition for a counterstreaming ion-ion instability and allows the system to be unstable even if the electron thermal energy is much smaller than the relative ion streaming energy. (auth)

17217 NONLINEAR BEHAVIOR OF STIMULATED BRILLOUIN AND RAMAN SCATTERING IN LASER-IRRADIATED PLASMAS. Forslund, D. W.; Kindel, J. M.; Lindman, E. L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 87544). Phys. Rev. Lett. 30: No. 16, 739-743 (16 Apr 1973).

Both analytic theory and inhomogeneous plasma simulations are presented to show the nonlinear development of the Brillouin and Raman backscatter instabilities. Nonlinear fluid behavior predicts a backscatter energy on the order of the incident laser energy, but particle trapping and heating effects associated with the excited electrostatic wave can significantly reduce this. (auth)

Thermonuclear Engineering and Equipment

17218 (COO-3028-5) RADIATION DAMAGE EFFECTS ON HYDROGEN PERMEATION IN FUSION REACTORS. Perkins, H. K.; Axtmann, R. C. (Princeton Univ., N. J. Dept. of Chemical Engineering). 1972. 18p. (CONF-730602-2). Dep. NTIS $3.00.

From 75th national AIChE meeting; Detroit, Michigan, USA (3 Jun 1973).

The intense particle fluxes that bombard the vacuum walls will change the transport rates of hydrogen isotopes through the walls. Radiation damage may thus affect both system operation (e.g., tritium recovery cycles; gas release into the plasma) and the useful lifetime of the wall (e.g., embrittlement; erosion). Some preliminary conclusions and directions for further research are indicated. (auth)

17219 (IPP-4/109) TRANSIENT BEHAVIOUR OF CURRENTS AND FORCES IN THE COIL SYSTEM OF THE W VII STELLARATOR, PARTICULARLY IN THE EVENT OF OPERATING TROUBLE. Preis, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Mar 1973. 38p. (In German). Dep. NTIS (U. S. Sales Only) $4.00.

Toroidal magnetic field configurations for magnetic confinement of plasma now occupy a prominent place in plasma physics. The Garching W VII Stellarator, now being built, is an experiment of this type. This report deals with the energy supply to the coils system (40 toroidally arranged single coils) by means of a high-power pulse generator and also treats the problems entailed. What is actually involved is the determination of the transient coils currents during a pulse cycle. This calculation is done for trouble-free operation and for the case of sudden coil shorting. The currents calculated, with allowance for all inductive coupling of the coil arrangement, are used for determining the magnetic forces (Lorentz forces). The forces exerted on the coils in the event of operating trouble are determined as functions of both the time and short-circuit resistance. (auth)

17220 (LA-5292-MS) ENERGY LOSS IN SUPERCONDUCTING MAGNETIC ENERGY STORAGE COILS. Weldon, D. M. (Los Alamos Scientific Lab., N. Mex.). May 1973. 13p. Dep. NTIS $4.00.

A simplified analysis is carried out to estimate the energy loss in some of the superconducting magnetic energy storage coils constructed or planned in connection with the Los Alamos Scientific Laboratory plasma physics program. (auth)

17221 (LA-5314-MS) DESIGN OPTIONS AND TRADE-OFFS IN SUPERCONDUCTING MAGNETIC ENERGY STORAGE WITH IRREVERSIBLE SWITCHING. Laquer, H. L.; Lindsay, J. D. G.; Little, E. M.; Rogers, J. D.; Weldon, D. M. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 17p. Dep. NTIS $4.00.

A program is presently under way at Los Alamos to determine how superconducting magnetic energy storage in conjunction with normal-going superconducting switches can be made to deliver the energies of the order of 200 MJ that will be needed for plasma compression in a pulsed Θ-pinch scientific feasibility experiment. After a review of the circuit configurations, the properties of commercially available and of some developmental superconductors relevant to both the energy storage coil and to the switch are discussed. Critical current densities at low fields and stability requirements both with respect to rapidly changing external fields and to self fields are of particular importance in determining optimum operating fields and temperatures. The trade-off between eddy current losses in the stabilizing material and the need for coil protection if a coil normalcy should occur is described. Problems in potting or other forms of mechanical stabilization for both superconducting elements are pointed out. The experimental phenomenon of an only partially normalized superconducting switch is described as are the conditions for attaining fully normal resistance. A number of cryogenic engineering problems are discussed briefly, including the requirements for plastic, non-conducting dewars and for a staged refrigerator to re-cool the switch in the most economical manner. Results of 20-kJ energy transfer experiments into both resistive and inductive loads are given and the design parameters are reported for a 300-kJ experiment now under construction. (25 figures, 30 references) (auth)

17222 (ORNL-TM-4050) MECHANICAL STRESS IN THE PRESSURE VESSEL OF A LITHIUM-FILLED, EXPLODING PELLET, THERMONUCLEAR REACTOR. Dresner, L. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 47p. Dep. NTIS $4.50.

The maximum strain produced in the vessel by the impact of pressure waves from the exploding pellet is estimated. The effect of including voids in the lithium is also discussed. (MOW)

17223 (ORNL-tr-2682) IGNITION TOKAMAK. Huguet, M.; Rebut, P. H. Translated by R. Gregg Mansfield (Oak Ridge National Lab.) from the French. 28p. Dep. NTIS $3.50.

A tokamak designed for ignition purposes is discussed in some detail. The magnet coils are described in terms of their electrical and mechanical characteristics. The poloidal field and the required fluxes are discussed. Power supplies are discussed also. (MOW)

17224 (UCRL-74792) PROTON SIMULATION OF A FUSION-REACTOR NEUTRON ENVIRONMENT. Logan, C. M.; Anderson, J. D. (California Univ., Livermore. Lawrence Livermore Lab). Jun 1973. 16p. (CONF-730813-2). Dep. NTIS $3.00.

From conference on defects and defect clusters in b. c. c. metals and their alloys; Gaithersburg, Maryland, USA (14 Aug 1973).

Body-centered-cubic refractory metals are strong candidates as first wall materials for fusion reactors. The neutron spectrum expected at the first wall is very different from that encountered in fission reactors. Little is known about the effects of this neutron flux on bcc metals. While the primary flux of 14-MeV neutrons born of the fusion reaction is but one-fourth of the total neutron flux, it is the dominant source of displaced atoms. The primary recoil spectrum in this environment is unlike that in any fission generated neutron spectrum. Current technology cannot duplicate the neutron flux and spectrum expected in a fusion reactor. Bombardment with other particles is the only available means of exploring the effects on metals of this unique environment. In order to simulate the reactor neutron spectrum, the incident particle must induce in bulk metal samples recoiling atoms with energies like those created by the neutron flux. A careful investigation shows that 16-MeV protons simulate very closely the energy spectrum of primary recoiling atoms expected in a D–T fusion reactor. Low-fluence irradiations of copper with 16-MeV protons and 14-MeV neutrons have produced damaged samples with identical cluster size distribution. Exposures of this type offer the prospect of performing radiation damage studies which are relevant to the controlled fusion program prior to the availability of an adequate fusion engineering test facility. (auth)

17225 STEP TOWARDS H ENERGY. de Closets, F. Sci. Avenir; No. 315, 416-421(May 1973). (In French).

It is shown that Tokamaks (the most recent and powerful being the TFR) offer the greatest possibility in the field of thermonuclear fusion. (FR)

17226 REACTOR IMPLICATIONS OF LASER-IGNITED FUSION. Hancox, R.; Spalding, I. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion; 13: No. 3, 385-391(Jun 1973).

Some technological and economic aspects of a superhigh-density inertially-confined laser-ignited thermonuclear reactor are discussed. Consideration of the economics of the system shows the importance of minimizing circulating power by using efficient lasers ($\eta_l \simeq 0.15$ to 0.3) and achieving a high burn-up in the compressed core. The importance of a high repetition rate ($f \simeq 50$ Hz) to permit an adequate margin in the capital cost of laser components is demonstrated. An estimate of typical costs for a 530 MW(e) deuterium–tritium fueled system which might compete with a fast fission reactor is presented. Economic operation of a pure deuterium fuelled system is shown to be much more difficult to achieve. Some physical factors which might affect the thermonuclear gain but which are not included in published computer predictions are discussed, including relativistic effects and topological problems which arise if the incident radiation is polarized. (auth)

17227 ROCKET-DRIVEN LINERS FOR FUSION TRIGGERS AND FOR VERY-HIGH-DENSITY REACTORS. Linhart, J. G. (EURATOM-CNEN, Frascati, Rome). Nucl. Fusion; 13: No. 3, 321-330(Jun 1973).

A simple theory of liner propulsion by material removal from the outer surface of the liner is outlined. It is shown that such liners should be able to compress and heat fusionable targets up to values of interest for pulsed thermonuclear fusion. Several conditions necessary for the achievement of fusion-power generation are discussed. (auth)

17228 CONTROLLED THERMONUCLEAR REACTOR FIRST WALL SPUTTERING AND WALL LIFE ESTIMATES. Laegreid, N.; Dahlgren, S. D. (Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Washington 99352). J. Appl. Phys. 44: No. 5, 2093-2096 (May 1973).

Equations and graphs are developed for rapid estimation of sputtering rates at the first wall of controlled thermonuclear reactors (CTR). High-energy particle sputtering yield data and potential particle fluxes are presently not readily available for most materials and many reactor designs, thus the equations were set up to provide rapid estimation of sputtering effects when data become available. Limiting wall sputtering-yield-particle-flux products were determined according to the equation $\Sigma S_\mu \phi_\mu < Kd(t')/t'$, where S_μ and ϕ_μ are the sputtering yield (atoms/particle) and flux (particles/cm^2 sec) of bombarding species μ, $d(t')$ is the allowable wall thickness removal (in cm) in t' years, and K is a material constant. K varied little (from 1.36×10^{15} to 3.28×10^{15}) for the wall materials considered (V, Mo, Nb, Ta, Zr, stainless steel, and Al_2O_3), so that a conservative estimate for the limiting sputtering-yield-particle-flux product is 10^{15} times the allowable sputtering rate in cm/yr. The sputtering yield in molecules per particle given for compounds such as Al_2O_3 must be multiplied by the number of atoms in the molecule to satisfy this relationship. Use of the equations to estimate wall sputtering of pulsed (high-β) and steady-state (low-β) reactors indicated that sputtering rates will be sufficiently high that they cannot be ignored. Factors reducing sputtering erosion rates, such as surface roughness, impurity effects, and sputtered material redeposition, are discussed. (auth)

17229 ESCAPE OF α PARTICLES FROM A LASER-PULSE-INITIATED THERMONUCLEAR REACTION. Krokhin, O. N.; Rozanov, V. B. Sov. J. Quantum Electron. 2: No. 4, 393-394 (Jan 1973).

A theoretical analysis is made of the escape of α particles generated in the synthesis of deuterium and tritium in a spherical plasma heated to a high temperature by laser radiation. Under these conditions an α particle is slowed down mainly by plasma electrons. Equations are obained for the fraction of the energy carried away by α particles outside the reaction zone and this energy is found as a function of the dimensions, temperature, and density of the plasma. (auth)

17230 LASERS AND THE REACTOR IGNITION PROBLEM. Spalding, I. J. (Culham Laboratory, Abingdon, Berkshire, England). Sov. J. Quantum Electron. 2: No. 4, 329-334 (Jan 1973).

Some published estimates of the laser energy (W_0) required to heat an inertially confined D—T target in a pulsed fusion reactor are summarized. Assuming a thermal efficiency of 1/3 and a laser heating efficiency (target energy/laser pumping energy) of 100%, most of these estimates of W_0 range between 10 and 1000 MJ, depending on the various assumptions which are made about the degree of solid-state target compression, the possibility of target tamping, and the required reactor power gain. Any energy gain due to fusion reactions in material other than the target is omitted in these calculations. These estimates of W_0 are then compared with the maximum fusion outputs which can be handled with and without damage to the structure and the low permissible cost of replacing damaged components is stressed. The possibility of using nonlinear absorption of repetitively pulsed CO_2 lasers to start up a steady-state stellarator which is fueled by D—T pellet injection and has an output of $\sim$10 GW(E) is then discussed. It is shown that laser energies as low as 80 kJ may be feasible and possible advantages and difficulties of such a hybrid inertial/magnetic confinement approach are outlined. (auth)

Wave Phenomena

17231 (COO-3632-9) SPECTRUM OF ELECTROSTATIC-FIELD FLUCTUATIONS IN A BOUNDED BEAM PLASMA SYSTEM. Diaz, C. J.; Walsh, J. E.; Conrad, J. R. (Dartmouth Coll., Hanover, N. H.). 1973. Contract AT(11-1)-3632. 27p. Dep. NTIS $3.50.

A theoretical study of the electrostatic field fluctuations of a bounded beam–plasma system in the regime below threshold for growing oscillations is presented. The spectrum exhibits a triplet structure in the neighborhood of the beam line. The structure is predicted on the basis of the electrostatic-wave emission model and the behavior of the dispersion relation for the bounded system. (auth)

17232 (FRNC-TH-369) INSTABILITY OF AN IONIZATION WAVE IN A PLASMA EXCITED AT ONE OF ITS hf RESONANCES. Peyre, A. (Paris Univ., Orsay (France)). 1972. 205p. (In French). Dep. NTIS (U. S. Sales Only) $12.25.

Thesis.

Ionization waves are often self-excited at low pressures (in excess of 20 mtorr) with small currents. A means was discov-

ered for rendering them unstable in low-pressure arcs (a few mtorr) in which their existence is less apparent. It was experimentally and theoretically demonstrated that these instabilities can occur as a result of a low-power hf field applied at one of the hf radial resonances of the plasma column (first Tonks–Dattner resonance on the principal dipolar resonance). Favorable conditions are always required: the operating point for the discharge should lie on the positive part of the absorbed hf power curve; this power must be greater than a certain critical value (200 to 300 mW). The agreement between the theoretical and experimental results (dispersion equation, wavelength of the maximum excited signal) is satisfactory in spite of the imperfections in the theoretical model chosen. Other problems are also evoked: the differences observed between the principal dipolar mode and the first Tonks–Dattner mode established the complicated behavior of the principal dipolar mode; the stationary variations of light under the action of the hf power applied to the plasma are probably due to phenomena of the same nature as ionization waves; the existence of moving or stationary striations in the hf plasma was not explained. (41 references) (FR)

17233 NONLINEAR WAVE MODULATION WITH ACCOUNT OF THE NONLINEAR LANDAU DAMPING. Ichikawa, Y. H. (Nihon Univ., Tokyo); Taniuti, T. J. Phys. Soc. Jap.; 34: No. 2, 513-521(Jan 1973).

The theory of nonlinear wave modulation in a collisionless plasma is developed on the basis of the Vlasov description, with particular attention to the nonlinear Landau damping process associated with resonance effects at the group velocity of the wave. Contributions from resonance particles, moving at the group velocity, change the nonlinear Schroedinger equation, derived in previous investigations. Besides giving rise to the nonlocal-nonlinear term, the contribution of these resonant particles reverse the sign of the nonlinear coupling coefficient, q, relative to the value calculated neglecting their effect. (auth)

17234 HYBRID RESONANCE DUE TO TWO-ION SPECIES IN A PLASMA. Toyama, H. (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 34: No. 2, 527-529(Jan 1973).

Hybrid resonance due to two-ion species (H^+ and H_2^+) was observed in a fully ionized plasma for the density range (2×10^{11} to 1.6×10^{12} cm^{-3}) using Stix-type induction coils. The dependence of the resonance condition, which was found experimentally, on the concentration ratio of the two ion species, was in good agreement with theoretical predictions. (auth)

17235 LIMITING MACH NUMBER OF AN EMBEDDED ION SHOCK. Grewal, Mahesh S. (Department of Mechanical Engineering, Wichita State University, Wichita, Kansas 67208). Phys. Fluids 16: No. 4, 561-562 (Apr 1973).

The ion Mach number seen by the ion shock embedded in a collisional shock propagating in an electron proton gas is found to reach a limiting value of 2.66 as the free stream Mach number goes to infinity. (auth)

17236 ELECTRON PLASMA WAVES IN AN UNBOUNDED UNIFORM MAGNETOPLASMA. Stenzel, R. L. (University of California, Los Angeles, California 90024). Phys. Fluids 16: No. 4, 565-567 (Apr 1973).

Electron plasma waves propagating perpendicular to B_0 in a weakly magnetized uniform plasma are observed above the upper hybrid frequency. Dispersion and damping follow classic laws. Application to high precision plasma diagnostics is pointed out. (auth)

17237 BALLISTIC SECOND-ORDER PLASMA WAVE ECHOES IN A MAXWELLIAN PLASMA. Ripin, B. H.; Pechacek, R. E. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland, 20742). Phys. Fluids 16: No. 4, 572-573 (Apr 1973).

Ballistic second-order plasma wave echoes are observed in a Maxwellian plasma. In some cases a small resonant coupling is also seen. (auth)

17238 DIRECT NONLINEAR COUPLING OF ELECTROMAGNETIC WAVES AND ELECTROSTATIC WAVES IN A PLASMA: THEORY. Van Hoven, Gerard; Phelps, David A. (Physics Department, University of California, Irvine, California 92664). Phys. Fluids 16: No. 4, 495-501 (Apr 1973).

Nonlinear coupling among small amplitude electromagnetic and electrostatic waves in a cylindrical plasma-column waveguide is analyzed theoretically. The warm plasma equations of motion, in the displacement/polarization format, are combined with the wave equation for guided transverse magnetic waves to derive the system dispersion relation and the coupled-mode equations for this configuration. The coupling coefficients predict the strength of a given multiwave interaction from the intrinsic properties of the plasma waveguide. When the frequency selection rule is satisfied, for wave numbers consistent with the system dispersion relation, off-resonance excitation will occur if the interaction is confined to a finite length of the waveguide. Typical interaction resonances are illustrated on the system dispersion diagram by an experimentally useful graphical construction. Numerical estimates of the coupling strengths of selected three-wave "scattering" and "radiation" interactions are made from data obtained with the aid of this diagram. The analytical results are then illustrated and interpreted. (auth)

17239 PARAMETRIC EXCITATION OF ION-ACOUSTIC WAVES IN A FULLY IONIZED PLASMA. Ohe, T. College Park, MD; Univ. of Maryland (1972). 153p. University Microfilms Order No. 73-17,045.

Thesis (Ph.D.).

Certain concepts in the analysis of lumped-parameter systems are extended to the analysis of distributed-parameter systems such as laboratory plasmas. The parametric excitation of a resonance in a physical system is accomplished by the periodic variation of the system parameter that corresponds to the "restoring force." The theoretical analysis and experimental observation of parametric excitation of ion-acoustic waves in a fully ionized plasma are described. The system parameter that corresponds to the restoring force is the electron temperature. (MOW)

17240 LOW AMPLITUDE TURBULENCE. Elsaesser, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Rep.; 8C: No. 1, 1-73(May 1973).

The statistical description of weakly interacting perturbations in a fluid is reviewed. The basic concepts are introduced using the thermal convection problem (Bénard problem) as an example. Equations for the Fourier coefficients of the temperature fields are derived, and a functional calculus describing correlations in a fluid is reconsidered. Three different intrinsic closures of the hierarchy of correlations are given; they correspond to three different propagation characteristics of the linearized equations of motion: Diffusion (as in the Bénard problem), dispersive waves, and acoustic waves. The amplitude equations for a weakly unstable plasma are discussed and solutions of the spectrum equation for several weak instabilities are reviewed. Measurements on collisionless shocks in laboratory plasmas are reported. (auth)

17241 NONLINEAR OSCILLATIONS OF AN UNSTABLE PLASMA. Abu-Asali, E.; Al'terkop, B. A.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1620-1626(May 1973). (In Russian).

The nonlinear frequency shift and nonlinear damping due to the production of higher unstable harmonics are considered as mechanisms for stabilization of an unstable wave in a plasma. The temporal evolution of the unstable wave amplitude up to the saturation stage is studied. An example of stabilization of an instability in the hot beam–cold plasma system is considered. (auth)

17242 COLLISIONLESS DAMPING OF INDUCED NONLINEAR PLASMA OSCILLATIONS. Fraiman, G. M. (Scientific-Research Radiophysics Inst., Gorky, USSR). Zh. Eksp. Teor. Fiz.; 64: No. 5, 1589-1596(May 1973). (In Russian).

Damping of a nonlinear standing wave in a plasma is considered. The amplitudes of the wave spatial harmonics are coupled due to nonlinearity under conditions of independent damping of separate harmonics. Damping of nonlinear Langmuir waves excited by a homogeneous external electric field is discussed in detail for the case of weak spatial dispersion and nonlinearity. (auth)

17243 NONLINEAR THEORY OF WAVE INTERACTION IN A PLASMA. Pustovalov, V. V.; Silin, V. P. Tr. Fiz. Inst., Akad. Nauk SSSR; 61: 42-283(1972). (In Russian).

A broad range of questions concerning the theory of the nonlinear interaction of a wave in an isotropic and magnetoactive plasma is considered. A generalized kinetic field equation in statistical nonlinear electrodynamics and a nonlinear dispersion equation are examined. The study of many-index tensors of a complex, dielectric penetrability, and the calculation of cross sections of concrete, nonlinear processes (induced combination scattering of a wave, and induced scattering of a wave by particles) are analyzed in detail. A plasma is described by a system of self-consistent equations without allowing for collisions. A derivation is given for a three- and four-index tensor of a complex, dielectric penetrability for a cold, isotropic and magnetoactive plasma within the framework of equations of two-fluid hydrodynamics. (107 references) (tr-auth)

17244 EXCITATION OF OBLIQUELY PROPAGATING CYCLOTRON HARMONIC WAVES. Hiroe, S.; Ikegami, H. (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 34: No. 2, 522-526(Jan 1973).

Obliquely propagating cyclotron harmonic waves are excited and their behavior is studied. The waves can be excited within the region that satisfies the condition, $\omega_p^2 > \omega^2 - \omega_c^2$. Contrary to the commonly accepted notion, it is confirmed that the cyclotron harmonic wave is in a propagating mode rather than in a standing mode. The wave numbers in the direction parallel to the magnetic

field lines are determined by the geometrical length of the lines. (auth)

17245 DAMPING OF ALFVEN AND MAGNETOACOUSTIC WAVES AT HIGH BETA. Grossmann, W.; Kaufmann, M.; Neuhauser, J. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). Nucl. Fusion; 13: No. 3, 462-464(Jun 1973).

Recent experimental data concerning damped Alfven waves in a theta-pinch-like plasma are reviewed and compared with existing theories. In addition to Alfven waves, compressional waves ($m = 0$, $k = 0$) are always excited in a theta pinch by the implosion phase. The damping of these faster compressional waves is also treated. (MOW)

17246 SURFACE OSCILLATIONS OF A MAGNETO-ACTIVE PLASMA. Lovetskii, E. E. (Moscow Inst. for Engineering and Physics). Nucl. Fusion; 13: No. 3, 331-340(Jun 1973).

Plasma oscillations of a wavelength that is large in comparison with the characteristic dimension of inhomogeneity of the plasma are discussed. Conditions are given for the existence and buildup of such oscillations, and possibilities of stabilizing them are indicated. The influence of collisions between charged particles and neutrals on surface oscillations is considered. (auth)

17247 EXCITATION AND DAMPING-MECHANISM OF WAVES AND RESONANCE IN BOUNDED MAGNETOACTIVE MEDIA. Prinzler, H. (Zentralinstitut fuer Elektronenphysik, Berlin). pp 1-6 of Plasma Physics. Prague; Ustav Fyziky Plasmatu CSAV (1972).

From 6th seminar on plasma physics; Liblice, Czechoslovakia (10 May 1972). See CONF-720588--.

Selected problems involving anomalous absorption and emission of electromagnetic waves are studied. Experimental methods and microwave diagnostics, an absorption mechanism and linear mode conversion, enhanced excitation due to groups of fast electrons, and enhanced excitation due to a nonlinear mechanism are considered. In most cases, the excitation and damping mechanism between the extraordinary wave and cyclotron-harmonic waves propagating perpendicular to the magnetic field is studied. (IAA)

17248 MOMENTUM OF QUASI-MONOCHROMATIC WAVES IN A PLASMA. Klima, R.; Petrzilka, A. (Inst. of Plasma Physics, Prague). pp 78-85 of Plasma Physics. Prague; Ustav Fyziky Plasmatu CSAV (1972).

From 6th seminar on plasma physics; Liblice, Czechoslovakia (10 May 1972). See CONF-720588--.

The questions of what is, in fact, the momentum of a wave packet in a plasma, and how this momentum (eventually its density) changes in various interactions are examined. A quasi-monochromatic transverse plane wave (wave packet) with a mean frequency omega propagating in an inhomogeneous plasma in the absence of a stationary magnetic field is considered, as well as the weak interaction of three waves. It is shown that the wave packet momentum (or the momentum density) of transverse waves is the sum of the Abraham momentum of the electromagnetic field and the mechanical momentum of the averaged motion of particles. (IAA)

17249 COLLISIONLESS DAMPING OF PLASMA WAVES. Arunasalam, V. (Princeton Univ., NJ). J. Phys., A (London); 6: No. 7, 1046-1049(Jul 1973).

Using the Weisskopf–Wigner theory of line broadening, an expression is derived for the natural width of the Landau resonance $\omega - k\ v = 0$. The conditions for the validity of the conventional quantum perturbation theory of plasmons and the collisionless damping due to nonresonant electrons are then examined. (auth)

17250 HARMONIC GENERATION AND PARAMETRIC EXCITATION OF WAVES IN A LASER-CREATED PLASMA. Bobin, J. L.; Decroisette, M.; Meyer, B.; Vitel, Y. (Commissariat à l'Energie Atomique, Centre d'Etudes de Limeil, 94–Villeneuve-Saint-Georges, France). Phys. Rev. Lett. 30: No. 13, 594-597 (26 Mar 1973).

We observed the light emitted along a direction 45° from the beam axis when a Nd-glass laser (frequency ω_0) was focused on a solid target. Quite intense lines were found with frequencies $2\omega_0$, $3/2\omega_0$, $1/2\omega_0$. The lines at $2\omega_0$ and $3/2\omega_0$ are broadened on the low-frequency side only. Their occurrence and broadening may be related to parametric excitation of waves. (auth)

17251 REFRACTION BY THE ELECTROMAGNETIC PUMP OF PARAMETRICALLY GENERATED ELECTROSTATIC WAVES. Arnush, Donald; Kennel, Charles F. (TRW Systems, Los Angeles, California 90278). Phys. Rev. Lett. 30: No. 13, 597-600 (26 Mar 1973).

In certain ionospheric and laboratory parametric–decay–instability experiments, pump–dependent refraction modifies the nature of the instabilities. In the ionosphere, electrostatic waves can be trapped in the gradients of the high–frequency pump. In the laboratory the refraction, and hence the convective nature of the instability, is determined completely by the pump. These simple examples suggest that pump–energy absorption may be enhanced by tailoring the pump profile to create a nonconvective instability. (auth)

17252 REFLECTION AND TRANSMISSION OF ELECTROMAGNETIC WAVES OBLIQUELY INCIDENT ON A RELATIVISTICALLY MOVING ISOTROPIC PLASMA SLAB. Kalluri, Dikshitulu; Shrivastava, R. K. (Department of Electrical Engineering, Birla Institute of Technology, Mesra, Ranchi, India). J. Appl. Phys. 44: No. 5, 2440-2442 (May 1973).

The oscillations in the power reflection coefficient as a function of the normalized incident wave frequency and slab velocity are shown for electromagnetic waves obliquely incident on an isotropic plasma slab relativistically moving along the slab interface. Both parallel and perpendicular polarizations of the wave are considered. (auth)

17253 CYCLOTRON HARMONIC WAVES IN A REFLEX DISCHARGE. Brand, G. F.; Cohen, D. D. (School of Physics, University of Sydney, Sydney, New South Wales, Australia). J. Appl. Phys. 44: No. 5, 2172-2176 (May 1973).

The propagation of cyclotron harmonic waves in a cold–cathode reflex discharge has been studied over a broad range of experimental parameters. Electron temperatures obtained from the waves and spectroscopic temperatures are in agreement but are an order of magnitude lower than double Langmuir probe temperatures. A non–Maxwellian electron velocity distribution for the plasma is suggested which can explain these results. (auth)

17254 ELECTROMAGNETIC INSTABILITY IN A COUNTERSTREAMING PLASMA. Seshadri, S. R. (Department of Electrical Engineering, The University of Wisconsin, Madison, Wisconsin 53706). J. Appl. Phys. 44: No. 5, 2115-2118 (May 1973).

An electromagnetic wave propagating obliquely to a counterstreaming plasma is shown to be unstable for all directions of the stream. The stream direction normal to the wave vector is a singular case for which the growth rate increases from zero as the wave number is increased and asymptotically approaches a maximum value for very large wave numbers. For all other directions unstable waves exist for wave numbers below a critical value and the growth rate increases from zero as the wave number is increased, reaches a maximum value, and then decreases to zero at the critical wave number. The maximum growth rate is found to be the same for all stream directions other than those very close to the normal to the wave vector. The dependence of the growth rate on the stream direction with respect to the wave vector and the validity of the quasistatic approximation in predicting the nature of this instability are also examined. (auth)

17255 EFFECT OF SATELLITE WAVES ON THE RESONANT THREE-WAVE COUPLING. Chang, J. (Sandia Laboratories, Albuquerque, New Mexico 87115); Chang, J. S. Phys. Fluids 16: No. 5, 706-708 (May 1973).

Resonant wave–wave coupling of a wave–triplet and its satellites are considered. The results show that by including the satellite waves the dynamic behavior of the coupled waves differs significantly from that of an isolated wave–triplet in both the explosive and the decay instabilities. (auth)

17256 A SIMPLIFIED DOUBLE PLASMA DEVICE FOR PLASMA WAVE STUDIES. Cohn, D. B.; Taylor, R. J.; Ault, E. R. (Department of Physics, University of California, Los Angeles, California 90024). Rev. Sci. Instrum. 44: No. 5, 639-640 (May 1973).

A variation of the DP (double plasma) device is described which allows the generation of plasma waves in the DP manner without the necessity for producing two separate plasmas. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 15608, 16136, 16233, and 16483.

17257 ELECTRON CURRENTS EXCITED BY GAMMA RADIATION IN MATTER. Zhemerev, A. V.; Medvedev, Yu. A.; Stepanov, B. M.; Trukhanov, G. Ya. At. Energ. (USSR); 34: No. 5, 399-401 (May 1973). (In Russian).

Expressions are derived that define the current of electrons produced by γ quanta in matter. It was assumed that the γ radiation flux changed slowly with time, in the course of which damping of fast electrons occurred. For example, in air under normal conditions, this time interval might amount to $\sim 10^{-9}$ to 10^{-8} s. The expressions were used to prepare a tabulation of values for the radial current of electrons produced by scattered γ-radiation over the time interval from 0 to 0.2 μs. (KSW)

17258 CALCULATION OF THE DENSITY OF NEUTRON MODERATION AND GAMMA QUANTA BY THE MONTE CARLO METHOD IN A HOMOGENEOUS INFINITE MEDIUM. Denisik, S. A.; Rezvanov, R. A.; Gommershtadt, V. Ya. Tr. Vses. Nauch. Issled. Inst. Yadern. Geofiz. Geokhim.; No. 9, 3-9(1971). (In Russian).

The distribution of moderated neutrons passing through a homogeneous medium was considered. Equations suitable for computer calculation using the Monte Carlo method were derived. The density distribution of gamma rays in water from a point ^{60}Co source was calculated; for 10,000 events the mean square error varied 1.2 to 3%, depending on source distance. The calculated results were compared with experimentally determined values, and the agreement was considered excellent. (2 figures) (RWR)

17259 DIRECT SOLUTIONS OF TIME-DEPENDENT NEUTRON SLOWING DOWN PROBLEMS USING NUMERICAL LAPLACE TRANSFORMS. 1. Infinite Media. Beynon, T. D.; Coleman, M. (Univ. of Birmingham, Eng.). J. Nucl. Energy; 27: No. 6, 425-433(Jun 1973).

A direct numerical inversion of the Laplace transform of the time variable is used to produce the time dependence of an infinite medium neutron field. Comparisons with exact solutions show that excellent agreement can be obtained by suitable scaling of the time variable. The examples chosen are slowing down in natural iron and slowing down and up-scattering in light water. (auth)

17260 INTEGRAL TRANSPORT THEORY CALCULATION OF NEUTRON FLUX DISTRIBUTIONS IN RECTANGULAR LATTICE CELLS. Wood, J.; Williams, M. M. R. (Queen Mary Coll., London). J. Nucl. Energy; 27: No. 6, 377-394(Jun 1973).

An integral transport theory method is described for calculating the flux distribution in an infinite, rectangular lattice, assuming mono-energetic neutrons and isotropic scattering. Important features of the method are: the rectangular cell boundary is treated exactly and the contribution of the surrounding cells to the reference cell is included explicitly. The method is implemented in a computer program, CELTIC, and a description is given of the numerical techniques used by the program to solve the singular integral equation. The convergence and accuracy of CELTIC is assessed by a comparison with exact analytic results which are obtainable for the spatially constant section case. Fluxes and disadvantage factors for the well-known Thie lattices are computed by CELTIC and compared with the results obtained by previous workers who used various transport techniques most of which rely on the cylindricalized cell approximation. The increase in accuracy resulting from the use of "White" boundary conditions rather than the reflecting boundary condition in the cylindricalized cell is demonstrated. The variation of the disadvantage factor as a function of the cell volume/fuel volume ratio is studied as the cell width decreases until the fuel region becomes the inscribed circle, for the case that the neutron cross sections remain unchanged. A minimum in the curve is found, which confirms previous results which, however, assumed spatially constant neutron cross sections in the square cell. (auth)

17261 FIRST FLIGHT ESCAPE PROBABILITY FOR A SPHERICAL SHELL WITH AN EMPTY CENTRAL REGION. Lefvert, T. (Foersvarets Forskningsanstalt, Stockholm). J. Nucl. Energy; 27: No. 6, 415-423(Jun 1973).

First flight transport kernels are derived for a spherical shell region where the central zone is empty. Assuming a uniformly distributed, isotropic source throughout the annulus the uncollided angular flux distribution is obtained enabling the formulation of the current at any point in the medium. It is shown that the current at the outer radius of the shell, and therefore also the escape probability P of the shell, can be put in a simple analytical form. Numerical values of P are given for different inner radii and different shell thicknesses and comparison is made with the escape probabilities for spherical shells with a black central region. Finally, an upper limit is given for the relative error introduced in a shell collision probability by the common assumption of a perfectly absorbing inner zone. (auth)

17262 DOSE DISTRIBUTION WITHIN A CYLINDRICAL WALL CONTAINING A SOLUTION OF β-EMITTERS, WITH APPLICATION TO THE GI TRACT. Unnikrishnan, K.; Sachdev, M. R.; Hukkoo, R. K. (Bhabha Atomic Research Centre, Trombay, India). pp 243-254 of Dosimetry in Agriculture, Industry, Biology and Medicine. Vienna; International Atomic Energy Agency (1973).

From symposium on dosimetry techniques applied to agriculture, industry, biology and medicine; Vienna, Austria (17 Apr 1972). See STI/PUB-311; CONF-720411-.

The distribution of dose inside the walls of cylinders of various radii containing material uniformly contaminated with β-emitters is calculated in two independent ways: (1) Using Berger's tables of scaled absorbed-dose distribution given in pamphlet No. 7 of the Medical Internal Radiation Dose Committee, and (2) by means of the conventional point dose function of Loevinger. Both the cylinder and the contents are assumed to be tissue equivalent for the purpose of calculation. Results are presented for various radionuclides having beta spectra with maximum energies between 0.25 to 2.25 MeV. Experiments using miniature thermoluminescent dosimeters of single crystal lithium fluoride (1 mm dia. $\times$ 1 mm long) embedded in the walls of Lucite tubes containing aqueous solutions of β-emitting isotopes are described, and the results compared with the calculated values. The application of these calculations to the dosimetry of the GI tract containing food contaminated with insoluble beta emitters is discussed. It is found that, in general, the method given in Report of Committee 2 of the ICRP leads to an overestimation of the dose. (auth)

Shielding Calculations and Experiments

Refer also to abstract 16201.

PHYSICS (THEORETICAL)

General

Refer also to abstracts 16622, 16796, and 17769.

17263 (JINR-P4-7183) THEORY OF PARTICLE REFLECTION BY ONE-DIMENSIONAL POTENTIAL BARRIERS. Babikov, V. V.; Musabaev, K. K. (Joint Inst. for Nuclear Research, Dubna, (USSR). Lab. of Theoretical Physics). 1973. 15p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

A method is suggested for construction of the reflection coefficient R for the case of one-dimensional ($-\infty < x < \infty$) potentials with exponential asymptotic forms. The method is based on the investigation of the properties of the Riccati type nonlinear equation for the reflection function B(x) and is tested with a number of concrete potentials for which the precise expressions of the reflection coefficient are known. (auth)

17264 (ORO-2911-15) INTERACTION OF HEAVY IONS WITH MATTER. Progress Report and Summary Report. Boring, J. W. (Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences). Jun 1973. Contract AT(40-1)-2911. 48p. (ESS-3930-110-73-U). Dep. NTIS $4.50.

A summary of research on processes that occur when a heavy atomic particle (ion, atom, etc.) interacts with matter is given with particular emphasis being given to the effects produced on biological systems. A list of publications is included. (JFP)

17265 NONCAUSAL PROPAGATION OF CLASSICAL RARITA-SCHWINGER WAVES. Singh, L. P. S. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 7: No. 4, 1256-1258 (15 Feb 1973).

The Rarita-Schwinger field coupled to scalar and Dirac fields is considered at the classical level. It is shown that the fermion fields satisfy a system of hyperbolic equations supplemented by initial conditions whose solutions propagate faster than light, thereby violating causality. (auth)

17266 POINT TRANSFORMATIONS IN QUANTUM MECHANICS. II. SOLVING FOR THE GENERATORS. Carmi, Gideon (Department of Physics, St. John's University, Jamaica, New York 11432). Phys. Rev. D 7: No. 4, 1044-1049 (15 Feb 1973).

We generalize the method and the results of paper I (G. Carmi, preceding paper) to find the generators of a point transformation which maps the x_i, $i=1,...,n$, into any set of functions $\omega_i(x_1,...,x_n)$, $i=1,...,n$, within a certain, quite wide family, for which these generators can be written in closed form, with the object of applications to a quantum many-body method developed by Gross et al.. (auth)

17267 SUMMATION OF PERTURBATION SERIES IN QUANTUM MECHANICS. Rae, Anil C. (Department of Physics, Indian Institute of Technology Kanpur, I. I. T. Post Office, Kanpur, U.P., India). Phys. Rev. D 7: No. 4, 1018-1027 (15 Feb 1973).

This is the first in a series of papers. It deals with the linked-cluster summation of the perturbation series in quantum mechanics and quantum statistical physics. In particular, a formalism is developed for calculating the matrix element of the operator $\exp(+sH)$, where H is the quantum-mechanical Hamiltonian operator. It is found that the matrix element may be written as an ordinary c-number integral of a c-number function over the phase space. This function is found by doing a linked-cluster summation of the usual perturbation series. It is in the form of an effective Hamiltonian, H_{eff}, which is a function of the parameter s and the c-number momentum and position coordinates. We have assumed that the Hamiltonian has no spin-dependent terms. The matrix element is written is such a form that it may be used for calculating the transition matrix elements in time-dependent perturbation theory as well as for calculating the canonical partition function Z_N in quantum statistical mechanics. The former is obtained by substituting $s=-it/\hbar$ and the latter by substituting $s=-\beta$. The series for H_{eff} depends only on the potential and is independent of the statistics. The effects of the statistics (Bose-Einstein, Fermi-Dirac, or Maxwell-Boltzmann) are all included in a certain factor multiplying $\exp(sH_{eff})$. Thus we have succeeded in separating the statistical and quantum corrections. These latter arise from the noncommutativity of the position and momentum operators. The effective Hamiltonian is an infinite series. A diagrammatic technique is given for evaluating this series. It is an expansion in powers of the coupling constant and can also be expanded in powers of Planck's constant. In general, it is not possible to give a closed-form expression for H_{eff}. But for most practical cases it is sufficient to keep the first few powers of Planck's constant $\hbar$, because it is very small. We therefore have an entirely new method of approximation. The statistical effect may always be included exactly. No numerical estimates are made in this paper. (auth)

17268 POINT TRANSFORMATIONS IN QUANTUM MECHANICS. I. THE RELATIVISTIC POTENTIAL PROBLEM. Carmi, Gideon (Department of Physics, St. John's University, Jamaica, New York 11432). Phys. Rev. D 7: No. 4, 1038-1044 (15 Feb 1973).

We derive a unitarity transformation which transforms a Hamiltonian of the form $(p^2+m^2)^{1/2}-(m^2)^{1/2}+V(x)$ into $p^2/2\mu+V((1/2)xQ+(1/2)Qx)$, where $\mu=$const, $(x,p)=i\hbar$, and $Q=Q(p)=(p^2+4)^{1/2}/p^2+2$ $\operatorname{arccosh}(1/2)(p^2+2)/\operatorname{arccosh}(1/2)[(p^2+2)^2-2]$ ($\simeq 1/2p$ for large p). Classicaly, $\dot{p}=-V'Q$, i.e., instead of incorporating the increase of inertia with velocity into the kinetic term of the Hamiltonian, it is equally possible to do so by making the potential part velocity-dependent, in just such a way that it will find it increasingly difficult to accelerate a particle with constant mass as the velocity grows. The generator of the transformation is $S=[xf(p)+f(p)x]2\hbar$, where $f(p)=-(1/2)(\ln 2)(p^2+4)^{1/2}\operatorname{arccosh}(1/2)(p^2+2)$. Some other related transformations are given and some applications are indicated. This paper is the first of a series in which quantum-mechanical point transformations will be discussed; in particular, S will be found in closed form for which $e^{-iS}(p \text{ or } x)e^{iS}=\omega(p)$ or $\omega(x)$, where ω is any prescribed function belonging to a wide family of functions, with the object of applications to superfluidity and quantum plasmas. (auth)

17269 ANHARMONIC OSCILLATOR. Lu, P.; Wald, S. S. (Department of Physics, Arizona State University, Tempe, Arizona 85281); Young, B. L. Phys. Rev. D 7: No. 6, 1701-1707 (15 Mar 1973).

We solve the anharmonic-oscillator problem as given by Bender and Wu to include the $\hbar^4$ terms for the energy eigenvalues and the $\hbar^2$ terms for the eigenfunctions by means of the Miller and Good modified WKB method. This is done by accepting the harmonic oscillator as a solved problem. We see that in doing so, not only can we get better energy eigenvalues, but also we can get improved eigenfunctions. (auth)

17270 PRESYMMETRY OF CLASSICAL RELATIVISTIC FIELDS. Avishai, Y.; Ekstein, H. (Argonne National Laboratory, Argonne, Illinois 60439). Phys. Rev. D 7: No. 4, 983-991 (15 Feb 1973).

The physical act of accelerating observation instruments has an obvious counterpart in Newtonian physics: It is the transformation induced by $(\vec{x},t)\to(\vec{x}+\frac{1}{2}\vec{a}t^2,t)$. In special relativity, a theoretical counterpart for physical acceleration has been introduced only for a small subset of measurement procedures, such as clocks and yardsticks, but not for such instruments as accelerometers. We propose a general theoretical counterpart for physical accelerations in Minkowski space. In the algebra O of observation procedures, it induces automorphisms, not of O but of a point subalgebra $O_x \subset O$ that is associated to a single point x. From the postulates of presymmetry, we deduce a generalized version of Newton's second law; an acceleration-invariant subset $U_{(x|x_0=0)}O_{xc}$ of instant observation procedures provides complete predictive power. The main technical contribution of the paper is the introduction of a topological algebra O in which local subsets associated to a single point are proper (although unbounded) subalgebras, whose automorphisms are discussed. (auth)

17271 PROPOSAL FOR FUNDAMENTAL THEORY OF PHYSICS. Heerden, P. J. van (Polaroid Research Laboratories, 750 Main Street, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 6, 1609-1619 (15 Mar 1973).

The theory is based on a new hypothesis on the nature of matter. This hypothesis is that the elementary particles, atoms, and molecules we have found in nature are not part of the real world, but constitute information about the real world. They are the wave components of a generalized Fourier analysis of our observations (which in the final analysis are always space-time distributions of photon—or particle-counter clicks). This Fourier analysis should be so general that every observation can be expressed in its terms; it thereby becomes axiomatic. Physicists of past generations, with their sound instincts, were intuitively approaching this most general and most powerful possible analysis of our observations. With the discovery of quantum mechanics, this development had advanced so far that the precise formulation of this ultimate analysis could be guessed. The model which can guide us to this mathematical formulation is that of an ideal optical observation on a physical object. This observation is made by illuminating the object with a finite number of laser beams of known amplitude and phase, and observing the amplitude and phase of the finite number of light beams emerging from the object space. The assumption that this is all the information we can ever obtain about the object leads to a wave function of the object which consists of light waves, extrapolated from the photon detectors back to the object space. It is suggested that these light waves should be presented as a product

of amplitudes in a 4n-dimensional space, where n is the number of light quanta in the signal. Most important, force, or interaction, can then be described as a linear transformation in this space. The actual mathematical formalism proposed on the basis of that model is $Xf=it\,df/dt$. X is the Hamiltonian of the whole universe wirh $n_0 \simeq 10^{80}$ particles. It is a $4n_0 \times 4n_0$ linear matrix operator. f is a $4n_0$-component vector wave function representing waves traveling at the speed of light. The coordinates are the homogeneous coordinates $(x_i y_i z_i u_i)$ of the n_0 particles in the closed universe. The eigenvalue ω, in $Xf=\omega f$, is a $(4n_0 \times 4n_0)$ Hermitian matrix. It can be divided into $n_0 \times n_0$ 4×4 submatrixes, each representing a complete set of dynamic and inertial quantities of elementary particles, or interaction quanta between particles. it $df/dt=\omega f$ is therefore a complete expression of the dynamic conservation laws. A special orthogonal transformation α_0 transforms the solution into a standard solution with eigenvalue ω_0, representing n_0 identical elementary particles. The assumption that the universe is of maximum probability then leads to simple explicit expressions for all matrix elements of ω_0. This means that the energy levels of all n-particle systems (atoms or molecules) of the theory can be directly calculated. The equations demand relations between cosmological constants and atomic constants. In a universe of the size and mass of our observed universe, the elementary particle would have to be of the size of the proton.

17272 ANHARMONIC OSCILLATOR. II. A STUDY OF PERTURBATION THEORY IN LARGE ORDER. Bender, Carl M. (Department of Mathematics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139); Wu, Tai Tsun. Phys. Rev. D 7: No. 6, 1620-1636 (15 Mar 1973).

This paper is concerned with the nature of perturbation theory in very high order. Specifically, we study the Rayleigh–Schroedinger expansion of the energy eigenvalues of the anharmonic oscillator. We have developed two independent mathematical techniques (WKB analysis and difference-equation methods) for determining the large-n behavior of $A_n{}^K$, the nth Rayleigh-Schr*dinger coefficient for the Kth energy level. We are not concerned here with placing bounds on the growth of $A_n{}^K$ as n, the order of perturbation theory, gets large. Rather, we consider the more delicate problem of determining the precise asymptotic behavior of $A_n{}^K$ as $n \to \infty$ for both the Wick-ordered and non-Wick-ordered oscillators. Our results are in exact agreement with numerical fits obtained from computer studies of the anharmonic oscillator to order 150 in perturbation theory. (auth)

17273 STABLE TRAJECTORIES OF DYNAMICS AND THE SCHRODINGER AND KLEIN–GORDAN EQUATIONS. Pyragas, K. A.; Alexandrov, A. N. (Inst. for Theoretical Physics, Kiev). Tensor; 23: No. 3, 337-343(Dec 1972).

The Poincare–Liapunov–Chetaev necessary condition of stability of the trajectory is obtained in covariant form. The relation obtained leads to the Schroedinger equation in an arbitrary curvilinear coordinate system. By making use of a covariant Hamiltonian form of the equations of motion of a test body this condition leads to the Klein–Gordan equation. (JFP)

17274 TREDER'S INTERPRETATION OF EINSTEIN'S UNIFIED FIELD THEORY. Buchner, K. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1421-1422(Oct 1972).

17275 ADIABATIC SWITCHING-OFF OF INTERACTIONS AND FOUNDATIONS OF THE BOLTZMANN EQUATION. Nishigori, T. (Osaka Univ., Suita, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1154-1172(Oct 1972).

The Boltzmann equation for a monatomic gas is derived with the aid of the adiabatic switching-off of interactions, starting with the Heisenberg equation of motion for a number operator in phase space introduced by Ono. It is shown that neither Kirkwood's time-averaging procedure nor the random phase approximation is necessary by virtue of the switching-off of interactions and a new method of time-differentiation. The effectiveness of the present formalism is demonstrated in an analysis of higher order interactions, and the Boltzmann equation is corrected so as to include multiple scattering effects. (auth)

17276 ALGEBRAIC TREATMENT OF QUANTUM-MECHANICAL MODELS WITH MODIFIED COULOMB POTENTIALS. Bednář, M. (Institute of Physics, Czechoslovak Academy of Science, Prague, Czechoslovakia). Ann. Phys. (N.Y.) 75: No. 2, 305-331 (Feb 1973).

Nonrelativistic models with modified Coulomb potentials are solved by an algebraic method based on SO(4,2) dynamical group. The nonrelativistic model with Yukawa long-range potential and the Stark effect in the nonrelativistic hydrogen atom in the homogeneous and inhomogeneous external electrostatic fields are studied in details. The algebraic method for the Dirac and Klein–Gordon relativistic hydrogen atom as well as relativistic models with the rotationally symmetric modified Coulomb potentials are also discussed. (auth)

17277 MOTION OF A PARTICLE IN AN OMEGA POTENTIAL WHICH IS A RELATIVISTIC INVARIANT. Durand, E. (Univ., Toulouse). Compt. Rend., Ser. A, B; 276: No. 13, 965-967(26 Mar 1973). (In French).

A theory has recently been presented together with an example of its application to a linear oscillator. Another theory is proposed which leads to much simpler results. It is identical to that given by Louis de Broglie for the motion of a particle in the quantized potential of the Klein–Gordon theory. (auth)

17278 GENERALIZED HAMILTONIAN DYNAMICS. Nambu, Yoichiro (The Enrico Fermi Institute and the Department of Physics, The University of Chicago, Chicago, Illinois 60637). Phys. Rev. D 7: No. 8, 2405-2412 (15 Apr 1973).

Taking the Liouville theorem as a guiding principle, we propose a possible generalization of classical Hamiltonian dynamics to a three-dimensional phase space. The equation of motion involves two Hamiltonians and three canonical variables. The fact that the Euler equations for a rotator can be cast into this form suggests the potential usefulness of the formalism. In this article we study its general properties and the problem of quantization. (auth)

17279 LINEAR ADIABATIC INVARIANTS AND COHERENT STATES. Malkin, I. A.; Man'ko, V. I.; Trifonov, D. A. (P. N. Lebedev Institute of Physics, Moscow, USSR). J. Math. Phys. (N.Y.) 14: No. 5, 576-582 (May 1973).

The Born–Fock adiabatic theorem is extended to all orders for some quadratic quantum systems with finitely or infinitely degenerate energy spectra. A prescription is given for obtaining adiabatic invariants to any order. For any quadratic quantum system with N degrees of freedom there are 2N linear adiabatic invariant series, which correspond to the 2N exact invariants. The exact quantum mechanical solution for any nonstationary quadratic quantum system is also constructed by making use of the coherent-state representation: The Green's function, coherent states, transition amplitudes and probabilities and their generating functions are obtained explicitly. Two particular systems, the N-dimensional time-dependent general oscillator and charged particle motion in a varying and uniform electromagnetic field, are considered in greater detail as examples. (auth)

17280 A NEW EXPANSION METHOD IN THE FEYNMAN PATH INTEGRAL FORMALISM: APPLICATION TO A ONE-DIMENSIONAL DELTA-FUNCTION POTENTIAL. Goovaerts, M. J.; Babcenco, A.; Devreese, J. T. (Institute of Applied Mathematics, Faculty of Science, University of Antwerp, Middelheimlaan 1, Antwerp, Belgium). J. Math. Phys. (N.Y.) 14: No. 5, 554-559 (May 1973).

An expansion method in the path-integral formulation of quantum mechanics, as proposed in a previous paper, is extended to account for states with odd parity. The method is tested on the case of a one-dimensional attractive delta-function potential and the well-known solutions for both bound and scattering states are obtained analytically by an exact summation of the expansion series. The applicability of the method is discussed and it is shown how the energy spectrum could be determined by means of Stieltjes theory of moments. (auth)

17281 RELATIONS AMONG ELEMENTS OF THE DENSITY MATRIX. I. DEFINITENESS INEQUALITIES. Band, William; Park, James L. (Washington State University, Pullman, Washington 99163). J. Math. Phys. (N.Y.) 14: No. 5, 551-553 (May 1973).

The statistical operator of quantum theory may be determined empirically by computations based upon the measured mean values of a set of observables we have called a quorum. The requirement that a statistical operator be positive semidefinite is then used to generate a family of inequalities connecting these quorum means. Like the simpler uncertainty relations, these inequalities are universal, valid for all quantum states. In the special case of pure states, the method yields a family of equalities. (auth)

17282 ON THE SUPPLEMENTARY SERIES OF $SO_0(P,1)$. Boyer, Charles P. (Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802). J. Math. Phys. (N.Y.) 14: No. 5, 609-617 (May 1973).

We construct multiplier representations of the unitary irreducible supplementary series of $SO_0(p,1)$ on the sphere S^{p-1} with the aid of a certain bilinear functional. The matrix elements of these representations are shown to be the analytic continuation of the matrix elements of the principal series. The decomposition of such representations with respect to the noncompact subgroup $SO_0(p-1,1)$ is then performed by the analytic continuation of the "overlap" functions. Furthermore, the expansion of the relevant bilinear functional on the hyperboloid H^{p-1} is performed, and the connection is made with the previous decomposition. (auth)

17283 THE EXPLICIT DETERMINATION OF THE LINEAR BOSON TRANSFORMATION COEFFICIENTS. Tanabe, Kosai (Department of Physics, Saitama University, Urawa, Saitama 338, Japan). J. Math. Phys. (N.Y.) 14: No. 5, 618-622 (May 1973).

The problem of determining the wavefunction is solved for the boson

Bogoliubov transformation. The method of series expansion is applied to derive the general expression for the coefficients which connect the new Fock states of an arbitrary number of quasiparticles with the states before the transformation. (auth)

17284 MIXED BASIS MATRIX ELEMENTS FOR THE SUBGROUP REDUCTIONS OF SO(2,1). Kalnins, E. G. (Centre de Recherches Mathématiques, Université de Montréal, Montreal 101, Canada). J. Math. Phys. (N.Y.) 14: No. 5, 654-657 (May 1973).

By using the irreducible decomposition on the two-dimensional light cone, the mixed basis matrix elements for the three subgroup reductions of SO(2,1) are calculated. These matrix elements are calculated for the principal series only and can be expressed in terms of well-known special functions. As a consequence of appearing in this context, some new properties of these special functions are given. (auth)

17285 HILL'S FUNCTIONS AND THE ONE-DIMENSIONAL SCHRÖDINGER EQUATION. Casey, K. F. (Department of Electrical Engineering, Kansas State University, Manhattan, Kansas 66506); Weaver, L. J. Math. Phys. (N.Y.) 14: No. 5, 647-650 (May 1973).

Over a region of finite width in which the potential varies with respect to a single Cartesian coordinate, it is possible to transform the one-dimensional Schrödinger equation into Hill's equation. It is thus possible to express the connection of the wavefunction and its normal derivative across the region exactly, in terms of the Fourier expansion coefficients of the potential profile. As a consequence, the reflection and transmission amplitudes and the bound-state energies associated with such a region may be directly calculated without actually solving an equation in the interior of the region. These results are applied to the solution of several examples, including the problem of s-wave scattering by a central potential. (auth)

Quantum Field Theories

Refer also to abstracts 16467, 16582, 16588, 16591, 16596, 16608, 16656, 16685, 16706, 16743, 16780, 16782, 16800, 17330, and 17784.

17286 (JINR-P2-7116) REDUCTION OF THE PROBLEM OF CALCULATION OF A CLASS OF INFINITE-DIMENSIONAL INTEGRALS IN QUANTUM FIELD THEORY TO THE SOLUTION OF INTEGRAL EQUATION. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1973. 19p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

In the quantum field theory with the self-action like $g\phi^4$ there appears the problem of the calculation of infinite-dimensional integrals. This problem is reduced to the solution of the integral equation of the type of equations for propagation function in the Feynman perturbation theory. (auth)

17287 LORENTZ-INVARIANT LOCALIZATION FOR ELEMENTARY SYSTEMS. V. GENRAL TRANSFORMATIONS. Kálnay, A. J. (Departamento de Física Atómica y Molecular, Instituto Venezolano de Investigaciones Científicas, Apartado 1827, Caracas, Venezuela); Torres, P. L. Phys. Rev. D 7: No. 6, 1707-1712 (15 Mar 1973).

In parts II and III of the present series of papers, the localization problem was studied for the cases of relativistic nonzero mass (spin 0, 1/2) and zero mass (spin 0, 1/2, and 1). With a set of postulates, of which the basic one is the imposition of Lorentz invariance of localization (LIL) (which is a self-consistency requirement), it was possible to define the position operator uniquely (except for a constant in the spin-1/2, nonzero-mass case). For the determination of the position operators it was enough to consider only very special cases of homogeneous Lorentz transformations. One of the purposes of the present paper is to consider the effect of arbitrary inhomogeneous continuous Lorentz transformations in order to obtain general Poincaré-invariant localization (GPIL). Our main result will be that localization is LIL if and only if it is GPIL. In II and III, LIL was obtained in spite of the fact that the position operators were not 4-vector operators but only 3-vector operators. In this paper, following Fleming, we construct formally covariant position operators from the 3-vector operators. We prove that their eigenfunctions are just the localized states defined in the GPIL sense. (auth)

17288 ANALYTICITY AND UNITARITY OF RELATIVISTIC OFF-SHELL MODELS. Greenman, J. V. (Department of Mathematics, University of Essex, Colchester, Essex, England). Phys. Rev. D 7: No. 4, 1225-1232 (15 Feb 1973).

In this paper we discuss two questions concerning off-shell relativistic models not involving integration over relative energy: (i) Is it possible to obtain a unitary off-shell model with simple potential whose singularity structure is a reasonable approximation to that of Mandelstam? (ii) Is it possible to derive an off-shell model satisfying two- and three-body unitarity by a consistent procedure from a basic field-theory model? On the first point we analyze the singularity structure of three proposed models satisfying two-particle unitarity and show that their singularity structures deviate as much from the Mandelstam form as that of the Blankenbecler–Sugar equation. On the second point we generalize one of these two-particle models to incorporate three-particle unitarity, deriving the generalization from an analysis of the ladder-approximated dressed-rung Bethe–Salpeter equation. (auth)

17289 QUANTUM FIELD THEORIES IN THE INFINITE-MOMENTUM FRAME. I. QUANTIZATION OF SCALAR AND DIRAC FIELDS. Chang, Shau-Jin; Root, Robert G. (Physics Department, University of Illinois, Urbana, Illinois 61801); Yan, Tung-Mow. Phys. Rev. D 7: No. 4, 1133-1146 (15 Feb 1973).

Renormalizable coupled scalar and Dirac field theories are quantized in equal-x^+ surfaces (called light fronts). Schwinger's action principle is employed to deduced the correct canonical equal-x^+ (anti-) commutation relations. These theories are shown to be Lorentz-invariant. Generalized Schwinger conditions for a quantum field theory to be Lorentz-invariant are given and discussed in an Appendix. Spectral sum rules are derived. Leading singularities of Green's functions and products of field operators near the light cone are studied and the implications to current algebra sum rules are discussed. We also discuss some of the delicate features of the light-front formulation. (auth)

17290 SPONTANEOUSLY BROKEN GAUGE SYMMETRIES. IV. GENERAL GAUGE FORMULATION. Lee, Benjamin W. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11790); Zinn-Justin, Jean. Phys. Rev. D 7: No. 4, 1049-1056 (15 Feb 1973).

The advent of the dimensional-regularization procedure allows the study of renormalizability of spontaneously broken gauge theories formulated in a wide class of gauges. We derive and study the Ward-Takahashi identities appropriate to such gauges. A consequence of the Ward-Takahashi identities is that the physical S matrix is invariant under a variation of the gauge condition. As remarked before, since the variation of a parameter in the R_ξ-gauge formulation shifts the masses of unphysical excitations, the above result, the ξ independence of the physical S matrix, implies that the unphysical excitations cannot contribute to the sum over intermediate states, establishing the unitarity of the S matrix. We also give the renormalization procedure of a model formulated in the R_ξ gauge. (auth)

17291 QUANTUM FIELD THEORIES IN THE INFINITE-MOMENTUM FRAME. IV. SCATTERING MATRIX OF VECTOR AND DIRAC FIELDS AND PERTURBATION THEORY. Yan, Tung-Mow (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. D 7: No. 6, 1780-1800 (15 Mar 1973).

The scattering matrix of coupled spin-one and Dirac field theories formulated in light-front quantization of the preceding paper is studied. The scattering matrix of the vector-gluon model in this new formulaton is shown to give the same predictions as in the equal-time formulation to all orders in perturbation theory. Renormalizability of this model in the new formulation is also established. A further test of the light-front quantization of spin-one fields is discussed by examples of fermion Compton scattering in the axial-vector-gluon model in the lowest-order perturbation theory. A reduction formula for vector particles is derived and the Wick theorem is proved. Peculiarities in the perturbation theory of the light-front formulation are discussed. Finally, a partonlike model for scattering of two energetic particles is proposed which satisfies manifest s-channel unitarity. (auth)

17292 QUANTUM FIELD THEORIES IN THE INFINITE MOMENTUM FRAME. III. QUANTIZATION OF COUPLED SPIN-ONE FIELDS. Yan, Tung-Mow (Lanoratory of Nuclear Studies, Cornell University, Ithaca, New York 14850). Phys. Rev. D 7: No. 6, 1760-1780 (15 Mar 1973).

Light-front quantization of spin-one fields coupled to a conserved or nonconserved current constructed from a Dirac field is studied. It is shown that an operator phase transformation must be performed on the Dirac field in order to maintain simple canonical commutation relations and a simple Hamiltonian. In this formulation quantum electrodynamics emerges as the zero-mass limit of the massive gluon model. Lorentz invariance of the vector-gluon model is explicitly verified. Vacuum expectation values of operator products and Green's functions are studied and spectral sum rules are derived. The general structure of the current commutators on a light front is formally not altered by the interactions. Feynman's parton model for deep-inelastic electron scattering is derived from canonical light front current commutation relations. The structure function in the Bjorken scaling limit is related to the p^+ distribution of the constituents of the hadron target in any frame of reference. (auth)

17293 NEW APPROACH TO FIELD THEORY. Fubini, S.; Hanson, A. J.; Jackiw, R. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). Phys. Rev. D 7: No. 6, 1732-1760. (15 Mar 1973).

A field theory is quantized covariantly on Lorentz-invariant surfaces. Dilatations replace time translations as dynamical equations of motion. This leads to an operator formulation for Euclidean quantum field theory. A covariant thermodynamics is developed, with which the Hagedorn spectrum can be obtained, given further hypotheses. The Virasoro algebra of the dual resonance model is derived in a wide class of 2-dimensional Euclidean field theories. (auth)

17294 EVANESCENT WAVES IN QUANTUM ELECTRODYNAMICS WITH UNQUANTIZED SOURCES. Ali, S. Twareque (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). Phys. Rev. D 7: No. 6, 1668-1675 (15 Mar 1973).

Evanescent waves are studied for a free field satisfying the Helmholtz equation and the results are employed in studying the nature of these waves in the case of a quantized electromagnetic field interacting with a given external source. The identity of these evanescent waves with virtual photons is established, and the result is used to analyze the field due to a uniformly moving charge distribution. (auth)

17295 SINGULAR FUNCTIONS OF TACHYON FIELD THEORIES. Murphy, Joe (Physics Department, Louisiana State University in New Orleans, New Orleans, Louisiana 70122). Phys. Rev. D 7: No. 4, 1260-1264 (15 Feb 1973).

We construct the singular functions of tachyon field theories in two dimensions and in four dimensions. Specifically, we give Poincaré-invariant solutions of the inhomogeneous Klein-Gordon equation with unit point source (the Green's functions), and the corresponding solutions of the homogeneous Klein-Gordon equation. (auth)

17296 QUANTUM FIELD THEORIES IN THE INFINITE-MOMENTUM FRAME. II. SCATTERING MATRICES OF SCALAR AND DIRAC FIELDS. Chang, Shau-Jin (Physics Department, University of Illinois, Urbana, Illinois 60801); Yan, Tung-Mow. Phys. Rev. D 7: No. 4, 1147-1161 (15 Feb 1973).

The scattering matrices of field theories formulated in the light-front quantization of the preceding paper are studied. Reduction formulas for scalar and Dirac particles are derived. The scattering matrices in this new formulation are shown to give the same predictions as in the equal-time formulation to all orders in perturbations. Second-order renormalization is carried out and it gives well-known results. New Feynman rules of the perturbation theory are given and their pecularities are discussed. (auth)

17297 REDUCTION FORMULAS FOR CHARGED PARTICLES AND COHERENT STATES IN QUANTUM ELECTRODYNAMICS. Zwanziger, Daniel (Department of Physics, New York University, New York, New York 10003). Phys. Rev. D 7: No. 4, 1082-1099 (15 Feb 1973).

A weak asymptotic limit is proposed for a charged field as an operator on the space of asymptotic states. This leads to a modified Lehmann-Symanzik-Zimmermann reduction formula and a determination of the singularity near the mass shell of the Green's function of a charged particle in the presence of other charged particles. Coherent states of the electromagnetic field are also reduced out. The resultant expression for S-matrix elements in terms of vacuum expectation values of time-ordered fields yields a slight elaboration of the Feynman rules which allows a perturbative calculation that is free of infrared and Coulombic divergences order by order. As an application, the amplitude for scattering of a Dirac particle by an external Coulomb potential is calculated to second order in the external potential, with a finite result. (auth)

17298 ZITTERBEWEGUNG IN RELATIVISTIC SPIN-0 AND -1/2 HAMILTONIAN THEORIES. Guertin, Ralph F.; Guth, Eugene (Physics Department, Rice University, Houston, Texas 77001). Phys. Rev. D 7: No. 4, 1057-1068 (15 Feb 1973).

By working in the Heisenberg picture, one of the present authors has previously given a general treatment of the charge-space Zitterbewegung of the coordinate in theories involving a Hamiltonian that factorizes the Klein-Gordon equation. In the present paper, this treatment is expanded, with particular emphasis being placed on the peculiar doubling of the dimension of the Hamiltonian due to Zitterbewegung. The two-component Weyl theory of the neutrino and four-component Dirac and two-component Sakata-Taketani theories for massive particles of spin 1/2 and 0, respectively, are discussed from the above viewpoint. The recent two-component theory of Biedenharn, Han, and van Dam (BHV) for massive spin-1/2 particles is analyzed. From our viewpoint, a Poincaré-invariant theory of this type necessarily has four components. We offer a two-component interpretation of the BHV theory at the expense of Poincaré invariance. This version cannot be generalized for an arbitrary electromagnetic field, in contrast to the four-component version. We also discuss the relation of the (first order in the time derivative) four-component BHV theory to the (second order) two-component Kramers theory. (auth)

17299 COVARIANT T-PRODUCT FOR FERMION FIELDS AND GAUGE INVARIANT VACUUM POLARIZATION AMPLITUDE. Capra, F. (Imperial Coll. of Science and Tech., London). Acta Phys. Austr.; 36: No. 3, 222-228(1972).

An electromagnetic current defined as the limit of a nonlocal expression in the fields is used to construct a covariant and gauge-invariant T-product for fermion fields. As an application of this procedure, the vacuum polarization amplitude is calculated and shown to be manifestly gauge-invariant. (auth)

17300 VARIED YANG AND MILLS FIELD. Kerbrat-Lunc, H. (Univ., Lyon). Compt. Rend., Ser. A, B; 276: No. 9, 711-713 (26 Feb 1973). (In French).

The variations in the Yang and Mills field curvature tensor defined in a Minkowski space-time are calculated. The varied Yang and Mills field equations are established together with the existence of a generalized Laplacian. (auth)

17301 FEYMAN RULES FOR THE HIGGS MODEL. Nishijima, K.; Watanabe, T. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 49: No. 1, 341-343(Jan 1973).

17302 AMBIGUITY IN PARTICLE INTERPRETATION OF A GAUGE FIELD OF THE YANG-MILLS TYPE. Okabayashi, T. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1375-1394(Oct 1972).

The breakdown of the invariance of a system described by a gauge field under the non-Abelian local gauge transformation group is studied in the radiation gauge systematically, first in classical theory and then in the Heisenberg picture. In quantizing the gauge field the commutation relations among field operators, the constraint and the wave equation are derived through the characteristics of displacement operators in Minkowski space. The requirement that the gauge field corresponds to a particle with unit spin is translated first in classical theory into two conditions on gauge functions. In quantum theory these conditions are replaced by more restrictive ones, and one also has to introduce another condition; the commutation relation of the gauge function with the conjugate momentum to the gauge field. Then the wave equation is covariant, and the covariance of the constraint can be proved without referring to the last condition. But the commutation relations among field operators are not invariant. Finally the particle-like aspects are studied by considering the interaction picture. Due to the breakdown of the symmetry there is an ambiguity specific to non-Abelian gauge fields in connecting operators in the Heisenberg picture and those in the interaction picture. It is shown that this ambiguity can be utilized, when quantizing the apparently massless classical gauge field, to obtain a massive gauge particle. (auth)

17303 SOME APPLICATIONS OF NORMAL-PRODUCT QUANTIZATION IN RENORMALIZED PERTURBATION THEORY. Gomes, M. O. C. Pittsburgh; Univ. of Pittsburgh (1972). 97p. University Microfilms Order No. 73-13,238.

Thesis (Ph. D.).

The linear relations among normal-product fields within Zimmermann's formulation of renormalized perturbation theory are investigated. The equations of motion and Zimmermann identities relating normal products of different degree are shown to exhaust the linear relations among composite fields. An enlarged class of Ward-identity anomalies is discussed, with reference to the breakdown of strict PCAC in a nonlinear sigma model. The absence of Callan-Symanzik coupling-constant renormalization in a massive Thirring model is demonstrated first up to fourth order by a direct graphical calculation and then to all orders using normal product methods. In the second method, the derivation depends on the mildness of the "anomaly" of the axial vector Ward identity in this model as well as on the special constraint between vector and axial-vector current in two dimensions. The asymptotic scale invariance of the vertex functions is established when the mass m tends to zero with the renormalization point μ either fixed (Gell-Mann-Low limit) or vanishing with m (Callan-Symanzik limit). (Diss. Abstr. Int., B)

17304 WICK EQUATION, THE INFINITE-MOMENTUM FRAME, AND PERTURBATION THEORY. Feldman, G.; Fulton, T.; Townsend, J. (Department of Physics, The Johns Hopkins University, Baltimore, Maryland 21218). Phys. Rev. D 7: No. 6, 1814-1824 (15 Mar 1973).

The eigenvalues of the Wick equation in the weak-binding limit are found in perturbation theory employing two different approaches: (1) a covariant approach using an integral representation for the Bethe-Salpeter wave function and (2) quantization in the infinite-momentum frame using the technique of Kogut and Soper. The eigenvalues agree to order $\alpha^3 \ln \alpha$. (auth)

17305 COMMENT ON AN EXACTLY SOLUBLE MODEL OF RELATIVISTIC FIELD THEORY. Białynicki-Birula, I. (Institute of Theoretical Physics, Warsaw University, Warsaw, Poland); Greenberg, O. W.; Sandusky, J. C. Phys. Rev. D 7: No. 6, 1928-1929 (15 Mar 1973).

Difficulties connected with the indefinite-energy version of a model of relativistic field theory are pointed out. (auth)

17306 COMMENTS ON GAUGE THEORIES WITHOUT ANOMALIES. Günaydin, Murat (Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. D 7: No. 6, 1924-1927 (15 Mar 1973).

Anomaly-free gauge theories corresponding to "safe" simple Lie groups classified by Georgi and Glashow are further analyzed under the requirement that they contain no fractionally or doubly charged particles. It is found that orthogonal groups SO(N) can satisfy this restriction when the leptons transform as an irreducible "fundamental" representation of SO(N). For the symplectic groups Sp(2N), this is true if the lepton representation is the adjoint representation or the representation ρ_2 defined below. If the leptons are to transform as the lowest-dimensional representation, it is necessary to consider product groups of the form Sp(2N) $\times$U(1). The exceptional group G_2 is ruled out. (auth)

17307 COVARIANT PERTURBATION THEORY FOR CHIRAL LAGRANGIANS. Šoln, Josip (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). Phys. Rev. D 7: No. 6, 1637-1646 (15 Mar 1973).

The formalism "partial differential equations with respect to coupling constants" is developed involving the total Lagrangian density. By means of this formalism the covariant perturbation theory is developed using the example of chiral Lagrangian for massless pions. Because our formalism involves the total Lagrangian density, the covariant perturbation theory easily follows by integrating the partial differential equation with respect to coupling constant for the S matrix. Thus our approach is more direct and simpler than the other approaches involving the interaction Hamiltonian density and which either use the functional techniques or the generating functionals of the time-ordered Green's functions. (auth)

17308 COMMENT ON THE ABSENCE OF RADIATIVE CORRECTIONS TO THE ANOMALY OF THE AXIAL-VECTOR CURRENT. Lowenstein, J. H. (Department of Physics, New York University, New York, New York 10003); Schroer, B. Phys. Rev. D 7: No. 6, 1929-1933 (15 Mar 1973).

The absence of radiative corrections to the Schwinger-Bell-Jackiw-Adler anomaly of the axial-vector-current Ward-Takahashi identity is demonstrated using normal-product methods. (auth)

17309 STATUS OF QED EXPERIMENTS. Hughes, V. W. (Yale Univ., New Haven). pp 1-32 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The status of tests of quantum electrodynamics through precision measurements on atoms and elementary particles is reviewed with particular emphasis on the experimental side. The precision tests of QED involve electrons, muons, and photons and their interaction with external electromagnetic fields. Fundamental atomic and auxiliary constants, the fine structure constant, hydrogen fine and hyperfine structure, muonium hyperfine structure, the electron g-value, the ac Josephson effect, further tests of QED, Lamb shift intervals for hydrogenic atoms with $Z > 1$, positronium fine structure, the muon g-value, and energy levels of muonic atoms are covered. (JFP)

17310 STATUS OF QUANTUM ELECTRODYNAMICS THEORY. Kroll, N. M. (Univ. of California, San Diego, La Jolla). pp 33-59 of Atomic Physics. III. Smith, S. J. (ed.). New York; Plenum Publishing Corp. (1973).

From 3rd international conference on atomic physics; Boulder, Colorado, USA (7 Aug 1972). See CONF-720857-.

The review of quantum electrodynamics covers computational problems bearing on the precision tests of quantum electrodynamics, high energy tests, gauge theories, and weak interactions. (JFP)

17311 ATTEMPTS TO CALCULATE THE ELECTRON MASS. Georgi, Howard M.; Glashow, Sheldon L. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). Phys. Rev. D 7: No. 8, 2457-2463 (15 Apr 1973).

In conventional quantum electrodynamics both the electron mass and the muon mass are free parameters, so that their ratio is arbitrary. In a unified theory of weak and electromagnetic interactions, this need not be the case. We examine models in which only the muon mass appears as a counterterm. The electron is massless in zeroth order, but develops a finite and calculable mass of order αm_μ. Unfortunately, the precise value of the electron mass depends on details of the models, and in particular on masses of unobserved vector bosons. (auth)

17312 CAN THE GENERALIZED HAAG THEOREM BE FURTHER GENERALIZED?. Santilli, R. M.; Ktorides, C. N. (Department of Physics, Boston University, Boston, Massachusetts 02215). Phys. Rev. D 7: No. 8, 2447-2456 (15 Apr 1973).

$L^\uparrow$-invariant n-point functions of scalar field theories satisfying the Wightman axioms are considered in the framework of the recently proposed inhomogeneous U(3,1)-invariant extension which is Weierstrass analytic in both the real and imaginary parts of complex four-vectors. The algebraic variety over which the extension is analytic is investigated, and it is shown that there is a shift in the appearance of singular points from $n \geq 6$, as for the customary complex analytic extension, to $n \geq 10$. The extended analyticity domain is investigated too, and it is proved that it contains all the spacelike points of the analyticity domain of the physical n-point function. A procedure to reach physical timelike separation, as well as any separation, is introduced, and it is shown that the above type of Weierstrass analyticity is sufficient to determine the physical n-point function at any separation from its value at spacelike separation. The above results are applied to the generalized Haag theorem in order to see whether its validity can be extended to more than the first four vacuum expectation values for the considered type of field theories. (auth)

17313 ON THE GREEN'S FUNCTIONS FOR THE BETHE-SALPETER EQUATION. II. Hormozdiari, Iraj; Huang, Justin C.; DeFacio, Brian (Physics Department, University of Missouri-Columbia, Columbia, Missouri 65201). J. Math. Phys. (N.Y.) 14: No. 5, 563-568 (May 1973).

Considering the Bethe-Salpeter equation as a relativistic equation, we have studied the free particle Green's functions for unequal mass scalar bosons, interacting via a translationally invariant potential. The scattering Green's function found by Huang and DeFacio (HD) is presented for all possible Ω-plane contours for the unequal masses case. Only two k-plane contours are found to be physically interesting. The casual, advanced, and retarded Green's functions are listed in an appendix for unequal masses for the physical contour. The timelike Green's functions again require severe restrictions on the interaction potential as found by HD, and possible Bethe-Salpeter bound states are briefly discussed. (auth)

17314 CONFORMAL INVARIANCE AND FIELD THEORY IN TWO DIMENSIONS. Gürsey, Feza; Orfanidis, Sophocles (Physics Department, Yale University, New Haven, Connecticut 06520). Phys. Rev. D 7: No. 8, 2414-2437 (15 Apr 1973).

The relevance of the representation theory of the conformal group to quantum field theory is illustrated in two dimensions by the Thirring model. Space-time position operators and their complex extensions are defined as operator-valued functions of the generators. These complex position variables coincide with the Gel'fand-Naimark labels and can be interpreted as labels for nonorthogonal coherent states. A Hilbert-space metric then becomes necessary. It is given by the matrix elements of the metric operator G and is nontrivial for the nonanalytic supplementary series and the analytic representations. In this case G^{-1} gives the two-point function for the Thirring model. For nonanalytic representations only weak (infinitesimal) conformal invariance holds for interacting fields if causal and spectral properties are imposed, while those properties become compatible with strong (global) conformal invariance in the case of analytic representations which lead either to free fields or to interacting fields with a quantized value of the coupling constant. (auth)

17315 WILSON EXPANSIONS AND THE DÜRR-WINTER IDENTIFICATION OF GAUGE POTENTIALS. Loos, Hendricus G. (Department of Mathematics, The Cleveland State University, Cleveland, Ohio 44115). Phys. Rev. D 7: No. 8, 2438-2447 (15 Apr 1973).

Dürr and Winter have shown that, for a spinor field ψ of dimension 1/2, an appropriately defined generalized Wick product $:\bar{\psi}\gamma_\mu L^i\psi:$ has the same gauge transformation as a constant times gauge potentials $b_\mu{}^i$, and that therefore one may consider the identification $b_\mu{}^i = a :\bar{\psi}\gamma_\mu L^i\psi:$. We investigate whether this procedure can be reconciled with a Wilson expansion. We show that if $:\bar{\psi}\psi:$ is uniquely determined by a Wilson expansion which does not involve a separate field of gauge potentials, but nevertheless is consistent with local gauge invariance in a Lorentz- and P-invariant theory, then the operator $:\bar{\psi}\gamma_\mu L^i\psi:$ constructed from the $:\bar{\psi}\psi:$ has the same local gauge transformation as gauge potentials multiplied by a constant. This result is obtained for the case that ψ is a one-component Dirac spinor field, and the gauge group is U(1), and also for a multicomponent Dirac spinor field transforming as the self-representation of the gauge group SU(n). It is shown that the Dürr-Winter definition for $:\bar{\psi}\gamma_\mu 1^i\psi:$ is a consequence of the Wilson expansion under the conditions stated. A class of Wilson expansions satisfying the uniqueness and consistency conditions is shown explicitly. (auth)

Gravitation and General Relativity

Refer also to abstracts 16360, 16372, 16373, and 16771.

17316 SCALE INVARIANCE AND SPECTRAL FORMS FOR CONFORMAL STRESS TENSORS. Milton, Kimball A. (Department of Physics, University of California, Los Angeles, California 90024). Phys. Rev. D 7: No. 4, 1120-1133 (15 Feb 1973).

For theories with dimensionless coupling constants, it is shown in the context of source thoery that unsubtracted single spectral forms for gravitational (stress tensor) vertices occur whenever the tensor which is invariant in the scaling limit is used to provide the primitive coupling of particles to gravity. Ward identities corresponding to gauge and scale invariance are derived, and it is observed that the former is ambiguous unless the requirement of consitency with scaling be imposed. Several examples of the theorem and identities are presented; in particular it is found that the dilation Ward identity fails for the Yukawa interaction, but this failure cannot be associated with an anomalous dimension. In this case, there is no anomaly in the vertex function, for the requirement of gauge invariance suffices to fix all subtractions. This pleasing state of affairs holds only when one of the basis tensors coincides with the conformal stress tensor. (auth)

17317 VECTOR AND TENSOR RADIATION FROM SCHWARZSCHILD RELATIVISTIC CIRCULAR GEODESICS. Breuer, R. A. (University of Maryland, College Park, Maryland 20742); Ruffini, R.; Tiomno, J.; Vishveshwara, C. V. Phys. Rev. D 7: No. 4, 1002-1007 (15 Feb 1973).

For the case of high multipoles we give an analytic form of the spectrum of gravitational and electromagnetic radiation produced by a particle in a highly relativistic orbit $r_0 = (3+\delta)M$ around a Schwarzschild black hole of mass M. The general dependence of the power spectrum on the frequency in all three spin cases (s=0 for scalar, s=1 for vector, and s=2 for tensor fields) are summarized by power $P \propto \omega^{1-s} \exp(-2\omega/\omega_{crit})$. Although they have the common feature of an exponential cutoff above a certain frequency ω_{crit}, the tensor case has much broader frequency spectrum than scalar or vector radiation. (auth)

17318 GYROMAGNETIC RATIO OF A MASSIVE BODY. Cohen, Jeffrey M. (Physics Department, University of Pennsylvania, Philadelphia, Pennsylvania 19104); Tiomno, Jayme; Wald, Robert M. Phys. Rev. D 7: No. 4, 998-1001 (15 Feb 1973).

It is well known that the gyromagnetic ratio (g factor) of a classical, slowly rotating body whose charge density is proportional to its mass density must be equal to unity. However, if the body is very massive the space time curvature effects of general relativity become important and the result g=1 is no longer valid. We calculate here the gyromagnetic ratio of a slowly rotating, massive shell with uniform charge density. When the shell is large compared with the Schwarzschild radius we have g=1, but as the shell becomes more massive the g factor increases. In the limit as the shell approaches its Schwarzschild radius we obtain g→2, the same value as for a Kerr–Newman black hole (and the same value as for an electron). We analyze the approach of the electromagnetic field to the Kerr–Newman electromagnetic field in this example and in the more general case of a point charge and magnetic dipole placed at the center of an uncharged rotating shell. We find that the magnetic dipole field outside the shell is the sum of two terms: (1) an intrinsic field resulting from the magnetic dipole of the source and (2) an induced field resulting from the rotation of the massive shell around an electrostatic charge. The first term gives the usual dipole field when the shell is large but vanishes in the black-hole limit; the second term is small when the shell is large but yields the Kerr–Newman electromagnetic field as the shell approaches its Schwarzschild radius. (auth)

17319 ELECTROMAGNETIC FIELD OF ROTATING CHARGED BODIES. Tiomno, J. (Institute for Advanced Study, Princeton, New Jersey 08540). Phys. Rev. D 7: No. 4, 992-997 (15 Feb 1973).

The fact that the electromagnetic field of the Kerr–Newman solution of the Einstein–Maxwell equations is independent of the gravitational constant calls attention to and is illuminated by a problem of flat-space physics: the field of a rotating charged oblate ellipsoid of revolution of infinite conductivity and either (a) magnetic susceptibility of vacuum or (b) infinite magnetic susceptibility. These problems are solved for the case of interest, when the angular velocity is $\omega_0 = a\bar{R}^{-2}$, where $\bar{R}^2 = R^2 + a^2$, R and $\bar{R}$ being the semiminor and semimajor radii of the ellipsoid, respectively. It is shown that, for small ω_0 the conductive surface current [case (a)] or the volume magnetization [case (b)] contributes to the total magnetic moment with twice the value of that generated by the convective current of the surface charge q. The multipole expansion of the fields $F_{\mu\nu}$ [same for (a) and (b)] is obtained and shown to be formally identical to one of the generalized Deutsch solutions obtained in the Appendix. These are the exact solutions for the electromagnetic field of rotating charged spherical perfect conductor with the magnetic susceptibility of the vacuum. Implications of these results for the understanding of properties of the Kerr–Newman black hole, such as the value 2 for the gyromagnetic factor, are analyzed. (auth)

17320 CONFORMAL ENERGY–MOMENTUM TENSOR IN RIEMANNIAN SPACE–TIME. Parker, Leonard (University of Wisconsin–Milwaukee, Milwaukee, Wisconsin 53201). Phys. Rev. D 7: No. 4, 976-983 (15 Feb 1973).

We consider the scalar field with quartic self–interaction in Riemannian space–time. Identities are proved which connect the modified energy–momentum tensors of Callan, Coleman, and Jackiw in different conformally related space–time. We consider the quantized scalar field in a conformally flat metric, and show that our identities relate the matrix elements of the modified energy–momentum tensor to corresponding matrix elements in Minkowski space. We show further, that when the mass can be neglected in the conformal wave equation there is no gravitationally induced particle creation in conformally flat space–times, thus generalizing a result proved earlier in the free–field case. The influence of additional fields and interactions on that result is briefly discussed. (auth)

17321 NON-DECOMPOSABILITY OF CERTAIN DEGENERATE LAGRANGE DENSITIES. Lovelock, D. (Univ. of Waterloo, Ont.). Tensor; 23: No. 3, 362-364(Dec 1972).

It is shown that in a certain sense the Pavelle result for the decomposition of a Lagrange density L is the best possible and that in the general case for $p > 1$, $L_{(p)}$ will never possess a decomposition of a certain given type. It is proven that $L_{(p)} = \mathcal{P} + D$, where $\mathcal{P} = \mathcal{P}(g_{ij}; g_{ij,k})$ and D satisfies the Euler–Lagrange equations identically. (JFP)

17322 INVARIANT CANONICAL EQUATIONS OF MOTION IN GENERAL RELATIVITY. Rund, H. (Univ. of Arizona, Tucson). Tensor; 23: No. 3, 365-368(Dec 1972).

It is proven explicitly that the Hamiltonian equations of motion proposed previously are tensorial. Also in order to substantiate the physical significance of these Hamiltonian equations it is shown by means of an example that the latter do in fact lead quite effortlessly to the equations of motion obtained previously for relativistic particles subject to the effects of various types of fields. (JFP)

17323 WAVE SOLUTIONS OF NON-SYMMETRIC UNIFIED FIELD THEORIES OF EINSTEIN, BONNOR AND SCHROEDINGER. Lal, K. B.; Singh, S. P. (Univ. of Gorakhpur, India). Tensor; 23: No. 3, 369-375(Dec 1972).

The wave solutions of nonsymmetric unified field theories of Einstein, Bonner, and Schroedinger in a given space–time are obtained. (JFP)

17324 SPEED OF SOUND IN A HIGH–PRESSURE GENERAL–RELATIVISTIC SOLID. Carter, B. (Institute of Theoretical Astronomy, University of Cambridge, Cambridge, England). Phys. Rev. D 7: No. 6, 1590-1593 (15 Mar 1973).

The characteristic equation for sound wave fronts in an elastic solid is derived in terms of the formalism recently developed by Carter and Quintana for the description of a perfectly elastic solid at high pressure in general relativity. A modified elasticity tensor (analogous to that used by Hadamard for the similar purposes in classical theory) is introduced in order to express the characteristic equation in a simple form. The equation is solved explicitly for the special case of a perfect (i.e., intrinsically isotropic) solid in (or sufficiently close to) its unsheared state. It is found that the squared sound speed is given by $d\tilde{p}/d\tilde{\rho} + 4\mu/3(\tilde{\rho}+\tilde{p})$ for longitudinal waves and by $\mu/(\tilde{\rho}+\tilde{p})$ for transverse waves, where $\tilde{\rho}$, $\tilde{p}$, and μ are the density, pressure, and modulus of rigidity, respectively. (auth)

17325 NEW CLASS OF SOLUTIONS OF THE EINSTEIN–MAXWELL FIELDS. Misra, R. M.; Pandey, D. B.; Srivastava, D. C.; Tripathi, S. N. (Department of Physics, University of Gorakhpur, Gorakhpur, India). Phys. Rev. D 7: No. 6, 1587-1589 (15 Mar 1973).

Maxwell fields in static axially symmetric space–time are discussed. A new method for generating the Weyl class as well as a more general class of electromagnetic fields is outlined. It has been shown that by the same procedure a new class of Maxwell fields can be generated which are not of Weyl type. A particular solution of this class is derived which represents an asymptotically flat gravitational field of a body possessing an electric or magnetic dipole moment. At large distances and in the case of a vanishing dipole parameter, the gravitational field goes over to the Schwarzschild field. (auth)

17326 POINCARÉ GAUGE INVARIANCE AND THE DYNAMICAL ROLE OF SPIN IN GRAVITATIONAL THEORY. Hayashi, K.; Bregman, A. (Max–Planck–Institut für Physik und Astrophysik, München, West Germany). Ann. Phys. (N.Y.) 75: No. 2, 562-600 (Feb 1973).

We classify, according to the number of independendent gauge fields, Poincaré gauge invariant theoretical frameworks of describing gravity into three categories. One of them may provide the dynamical definition of the spin tensor S and that of the energy–momentum tensor T, resulting in the response equation of matter to gravity with the

gravitational field strengths, D and F, coupled to the former tensors T_ν $^{\mu}{}_{;\mu} = D^{\cdot}{}_{\mu\lambda\nu}T^{\mu\lambda} + F_{\mu\lambda\nu p}$, where the right-hand side represents spin force densities. In the absence of spin the response reduces to the conventional one of general relativity, i.e., without the spin forces. For the electromagnetic field the phase-gauge invariance requires the same conclusion as for a scalar field. For a spin 1/2 particle there is torsion, which deflects its trajectory from geodesic; an explicit expression for torsion takes a simple form of the axial vector current $\psi\gamma_5\gamma_\mu\psi$. (auth)

17327 ARTIFICIAL SATELLITES AND EXPERIMENTAL VERIFICATION OF GENERAL RELATIVITY. Maugin, G. (Univ., Paris). Aeronaut. Astronaut. (Paris); No. 40, 19-23(Mar 1973). (In French).

A possible application of space research in the experimental verification of the general theory of relativity is presented. The experiment proposed by Schiff, which is currently being developed at Stanford, is presented. This experiment enables the relativistic precession of a gyroscope mounted on an artificial satellite to be studied. (FR)

17328 EXACT SOLUTION TO SALAM'S f-g THEORY OF GRAVITY. Aichelburg, P. C.; Mansouri, R.; Urbantke, H. K. (Univ., Vienna). Acta Phys. Austr.; 36: No. 1, 86-91(1972).

The well known plane fronted waves with parallel rays, exact solutions of the vacuum Einstein gravitational field equations, are generalized to exact solutions of the equations of f-g gravity theory proposed by Salam et al. in regions free from matter. (auth)

17329 GENERALLY COVARIANT TWO-TENSOR THEORY OF GRAVITATION. Mansouri, R. (Univ., Vienna). Acta Phys. Austr.; 37: No. 1-2, 152-174(1973). (In German).

A critique of the concepts of space, time and geometry of space and a discussion of geometrical interpretation of finite-range theory of gravitation proposed by Freund et al are given. Generalization of this theory leads to a generally covariant massive two-tensor theory of gravitation. It is shown that the linearized as well as the exact theory contains eight degrees of freedom, in contrast to f-g theory of Salam et al.: while the linearized f-g equations give just seven independent modes, the canonical formalism for the full theory gives eight, as in this case. Finally two theorems regarding the existence of trivial solutions of the equation are formulated. (auth)

17330 DID EINSTEIN MISUNDERSTAND THE QUANTUM PROBLEMATICS? Scherrer, W. Tensor; 25: 434-438(1972). (In German).

The imperfection of the quantum theory is closely connected with the abnormal one-sidedness of electrodynamics. These two themes are explained and it is shown that the relativistic wave mechanics show compelling position and momentum of an electron in contrast to the Bohr dualistic meaning. If one considers point electrodynamics in absolute space and transfers this into the time-space of the relativity theory, the phenomenon of the abnormal one-sidedness of electrodynamics is evident. A theory yielding a completely relativistic interaction is proposed. (J.S.R.)

17331 SPIN TWO FIELDS AND GENERAL RELATIVITY. du Plessis, J. C. (Univ. of the Witwatersrand, Johannesburg). Tensor; 26: 255-261(1972).

Gravity is treated as a classical spin-two field, which is a more direct method involving no approximation procedure, in order to narrow the gap between the gravitational field and other physical fields. The basic assumption is that total energy–momentum is conserved. (JFP)

17332 EXPERIMENTAL TEST OF WEYL'S GAUGE-INVARIANT GEOMETRY. Harris, E. G.; Huray, Paul G.; Obenshain, F. E.; Thomson, J. O. (The University of Tennessee, Knoxville, Tennessee 37916); Villecco, R. A. Phys. Rev. D 7: No. 8, 2326-2330 (15 Apr 1973).

Weyl's gauge-invariant geometry predicts that the periods of clocks are affected by their previous history in electromagnetic fields. We have used the Mössbauer effect to search for such an effect with negative results. (auth)

17333 RADIATION OF MASSIVE GRAVITATION. van Nieuwenhuizen, P. (Laboratoire de Physique Théorique et Hautes Energies, Centre National de la Recherche Scientifique, Orsay, France). Phys. Rev. D 7: No. 8, 2300-2308 (15 Apr 1973).

The radiation problem in massive and massless linear Einstein gravitation is analyzed for mass discontinuities in the limit of vanishing graviton mass m. It is found that in this limit: (i) the radiation into the massive modes of helicity ± 2 becomes equal to (3/4) of the total massless Einstein radiation, (ii) the radiation into the massive modes of helicity ± 1 tends to zero, and (iii) the radiation into the massive helicity–0 mode stays nonzero and is model-dependent. Two models illustrate this: (i) An oscillating point mass radiates for m–0 into the modes of helicity ± 2 and 0, and its total radiation approaches in this limit the massless Einstein radiation; (ii) a pulsar radiates for m–0, but only into the helicity–0 mode: Birkhoff's theorem is broken in linear massive gravitation. It is also broken in massive Maxwell theory, but holds in massless Maxwell theory. (auth)

17334 SOLUBLE TWO-DIMENSIONAL MODELS OF GENERALLY COVARIANT FIELD THEORIES. Klarfeld, Joseph; Harvey, Alexander L. (Department of Physics, Queens College of The City University of New York, New York, New York 11367). Phys. Rev. D 7: No. 8, 2309-2310 (15 Apr 1973).

Several soluble generally covariant field theories defined on a two-dimensional indefinite metric are discussed. The differential equations for the metrics are nonlinear and hyperbolic. These are solved in closed form. (auth)

17335 CHARGED VERSION OF TOMIMATSU-SATO SPINNING-MASS FIELD. Ernst, Frederick J. (Department of Physics, Illinois Institute of Technology, Chicago, Illinois 60616). Phys. Rev. D 7: No. 8, 2520-2521 (15 Apr 1973).

A solution of the coupled Einstein–Maxwell field equations is constructed from the recently published Tomimatsu–Sato solution of Einstein's vacuum field equations. (auth)

17336 GENERAL THEORY OF VACUUM ERGOSPHERES. Hajicek, P. (Institute of Theoretical Physics, University of Berne, Switzerland). Phys. Rev. D 7: No. 8, 2311-2316 (15 Apr 1973).

A general definition of ergosphere is given abstracting this sort of energy source from any particular solution of Einstein's equations. A classification of ergosphere boundary points is performed according to their local properties. Points of both classes are shown to be present on the boundary of a large subfamily of ergospheres called weakly bounded. This implies existence of a singularity or a black hole inside these ergospheres. Both known ergospheres, that for $a \leq m$ and that for $a > m$ in the Kerr solution, are weakly bounded. (auth)

17337 QUANTUM TREE GRAPHS AND THE SCHWARZSCHILD SOLUTION. Duff, M. J. (Physics Department, Imperial College, London SW7, England). Phys. Rev. D 7: No. 8, 2317-2326 (15 Apr 1973).

It is verified explicitly to second order in Newton's constant, G, that the quantum–tree–graph contribution to the vacuum expectation value of the gravitational field produced by a spherically symmetric c–number source correctly reproduces the classical Schwarzschild solution. If the source is taken to be that of a point mass, then even the tree diagrams are divergent, and it is necessary to use a source of finite extension which, for convenience, is taken to be a perfect fluid sphere with uniform density. In this way both the interior and exterior solutions may be generated. A mass renormalization takes place; the total mass of the source, m, being related to its bare mass, m_0, and invariant radius, ϵ_i, by the Newtonian–like formula, $m = m_0 - 3Gm_0^2/5\epsilon_i + O(G^2)$, and the infinities in the quantum theory are seen to be a manifestation of the divergent self–energy problem encountered in classical mechanics. (auth)

17338 GENERALIZED FERMI TRANSPORT IN GENERALIZED GRAVITATION THEORIES. Enosh, M. (Department of Physics and Atronomy, Tel–Aviv University, Ramat Aviv, Israel); Kovetz, A. J. Math. Phys. (N.Y.) 14: No. 5, 572-575 (May 1973).

If geodesics in space–time can be classified as timelike, null, and spacelike, the affine connection must be of the form $\Gamma^i{}_{jk} = \{^i{}_{jk}\} + 2g^{ia}e_{jka} - (\delta^i{}_j\delta^s{}_k + \delta^i{}_k\delta^s{}_j - g_{jk}g^{is})d_s$, with d_s an arbitrary vector and e_{ijk} a tensor satisfying $e_{(ijk)} = e_{[ij]k} = 0$. It is possible to generalize Fermi's law of transport to this affine connection. The requirement that any observer be able to constuct and maintain a nonrotating orthogonal space triad along his world line by the bouncing photon experiment implies the Weyl's geometry of paths. (auth)

17339 SIGNIFICANT DEVIATION OF ROTATIONAL DECAY FROM THEORY AT A RELIABILITY IN THE 10^{-12} SEC^{-1} RANGE. Fremerey, J. K. (Institute of Physical Chemistry, University of Bonn, 53, Bonn, Germany). Phys. Rev. Lett. 30: No. 16, 753-757 (16 Apr 1973).

New drag–versus–speed measurements with a freely spinning steel sphere in a cavity–type permanent–magnet suspension confirm the up–to–date theories of residual drag (Coriolis, eddy–current, and relaxation effects). A small excessive drag is of particular interest for the discussion of Keith's gravitational radiation effect. (auth)

17340 GENERATION OF STATIONARY EINSTEIN-MAXWELL FIELDS. Kinnersley, William (Physics Department, Montana State University, Bozeman, Montana 59715). J. Math. Phys. (N.Y.) 14: No. 5, 651-653 (May 1973).

The Einstein–Maxwell field equations in the presence of one Killing vector are shown to possess covariance under an eight–parameter group of linear substitutions in the field variables. This internal symmetry group is isomorphic to SU(2,1). Three of the degrees of freedom correspond to gage transformations, but the remaining ones allow us to generate a five–parameter family of solutions given a single solution. (auth)

REACTOR TECHNOLOGY AND REGULATION

17341 ACTIVITIES OF THE POWER REACTOR NUCLEAR FUEL DEVELOPMENT CORP. Kiyonari, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nucl. Eng. Int.; 18: No. 206, 556-558(Jul 1973).

The Power Reactor and Nuclear Fuel Development Corporation aims to achieve commercialization of advanced thermal reactors between 1975 and 1984, and of fast breeders between 1985 and 1994. An outline is given of the background to the development of the experimental fast reactor Joyo and the prototype breeder Monju, and of their present status. Light-water reactor technology is applied to the development of ATR's. A prototype ATR, Fugey, using slightly enriched U with Pu addition, is under construction. The corporation is conducting a survey of uranium resources both in Japan and abroad and is to undertake research and development including the construction of a pilot plant, for U enrichment by gas centrifuge. Work on fuel development, processing, and inspection technology is also mentioned. (UK)

17342 POLICY FOR DEVELOPMENT AND UTILIZATION OF ATOMIC ENERGY IN JAPAN. Narita, T. Nucl. Eng. Int.; 18: No. 206, 551-552(Jul 1973).

Various aspects of the development and use of atomic energy in Japan, based on the revised long term program, are briefly summarized. They cover power reactor development, fuel, safety, nuclear propulsion, utilization of nuclear heat, and use of radiation. Government investment in atomic energy, long term generating capacity, and development schedules for advanced power reactors including the FBR are presented. (UK)

17343 RESEARCH ACTIVITIES IN JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Murata, H. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Eng. Int.; 18: No. 206, 545-547(Jul 1973).

The three main categories of research and development undertaken by JAERI, in addition to basic research, are studies on systems in nuclear power generation, reactor safety and environment research, and the use of radiation technology in the plastics, food and isotope industries. The various activities in these fields are discussed. An outline is given of the proposed 50 MW(t) very high temperature reactor for studies in the utilization of nuclear heat from VHTGR's for steelmaking and other applications and also for the associated test loops. (UK)

17344 NUCLEAR POWER TECHNOLOGY IN THE USSR. Petrosyants, A. M. IVA Tidskr. Tek.-Vetensk. Forsk.; 42: No. 7, 227-234(1971). (In Swedish).

The organization of nuclear research in the USSR is briefly discussed and the development of the Soviet nuclear power program is described. The utilization of nuclear energy will be carried out in two phases; construction and building power reactors, at first with slow and later with fast neutrons. The prospects for the future within the nuclear energy field in the Soviet Union are also given. (auth)

17345 NEW NUCLEAR POWER STATIONS IN THE FEDERAL REPUBLIC OF GERMANY. Part 2. Atomwirt., Atomtech.; 18: No. 4, 179-190(1973). (In German).

A review is given on the nuclear power plants in the FRG which are being commissioned, constructed or planned. (UA) (GE)

17346 NUCLEAR POWER ACTIVITIES AT HITACHI. Nucl. Eng. Int.; 18: No. 206, 567-568(Jul 1973).

The aim of Hitachi Ltd in the nuclear energy field is in the planning, design, fabrication and construction of nuclear generating systems. In addition to BWR technology, research and development is also carried out on advanced thermal reactors, fast breeders, uranium enrichment, and environmental protection systems. (UK)

17347 NUCLEAR ACTIVITIES OF THE MITSUBISHI GROUP. Murata, Y. (Mitsubishi Atomic Power Industries, Inc., Tokyo). Nucl. Eng. Int.; 18: No. 206, 566-567(Jul 1973).

The Mitsubishi Group is one of the largest nuclear industry groups in Japan. The functions of the various members are described and a brief history is presented of the nuclear activities of the group. In addition to experience with PWR type of reactors, Mitsubishi in co-operation with other manufacturing groups is engaged in developing advanced thermal and fast breeder reactors, the high temperature gas cooled reactor being one of the large scale projects after 1973. (UK)

17348 ACTIVITIES OF SUMITOMO ATOMIC ENERGY INDUSTRIAL GROUP. Nucl. Eng. Int.; 18: No. 206, 569(Jul 1973).

A brief synopsis is given of the activities of the Sumitomo group in nuclear energy which cover most of the fuel cycle range. Each of the companies making components specializes in some aspect of fuel element fabrication, reprocessing or in the use of radioisotopes. A list of the principal achievements of the research and development sections in the installation of critical facilities and nuclear instrumentation is given. (UK)

17349 FLOATING NUCLEAR POWER PLANTS FOR OFFSHORE SITING. Collier, A. R.; Nichols, R. C. (Offshore Power Systems, Jacksonville, FL). Combustion; 44: No. 12, 10-16(Jun 1973).

Offshore siting of nuclear power plants will permit them to be located nearer load centers without competing for valuable land. The combination of a floating platform-mounted plant manufactured in a shipyard-type facility and an offshore site protected by a breakwater provides advantages in site acquisition, site development, and plant construction. The offshore nuclear plant also offers significant environmental benefits. To fully exploit the offshore nuclear plant concept, Offshore Power Systems, a joint enterprise of Westinghouse and Tenneco, has been formed to manufacture the floating plants. Commitments for the first two offshore plants have been received from Public Service Electric and Gas Company. However, additional orders from other utilities will be required if the enterprise is to be an on-going success for both the electric utility industry and the plant builder. (auth)

Power Reactors, Non-Breeding, BWR-Type

Refer also to abstracts 15265, 15976, 17506, 17520, and 17622.

17350 (GEAP-13317-2) BWR BLOWDOWN HEAT TRANSFER SECOND QUARTERLY PROGRESS REPORT, OCTOBER 1 – DECEMBER 31, 1972. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept). Dec 1972. Contract AT(04-3)-189. 21p. Dep. NTIS $4.00.

Heater rod thermocouple difficulties have been overcome and the first 16-rod bundle test series has been completed. The bundle survived repeated dryout, heatup, and rewet transients during blowdown conditions. Confidence in the basic design for use in 49-rod blowdown heat transfer tests has been reinforced, and better performance is projected for the second 16-rod bundle. Design work for the two-loop test apparatus was completed and procurement is well under way. (3 references) (auth)

17351 (IAEA-143(Vol.1), pp 329-340) CRITICAL EXPERIMENTS ON TWO REGIONAL WATER LATTICE CORE. Matsuura, S. (Japan Atomic Energy Research Inst., Tokai); Kobayashi, I.; Tsuruta, H.; Miyawaki, Y.; Yumoto, R.; Kikuchi, S. 1972.

From panel on plutonium recycling in thermal power reactors; Vienna, Austria (21 Jun 1971).

Preceding the commercial utilization of plutonium in large BWR, a serial irradiation and burnup study of plutonium fuel assembly using Japan Power Demonstration Reactor (JPDR) is planned. As a part of this program, a set of critical experiments on two zone cores which consisted of PuO_2-UO_2 and UO_2 lattices has been carried out at Tank-type Critical Assembly (TCA). Two types of PuO_2-UO_2 fuel rods, one for BWR and the other for PWR were employed. Effective multiplication factor, power and neutron flux distribution, lattice parameters and β/l were measured parametrically changing the water to fuel volume ratio in PuO_2-UO_2 lattice. It is confirmed that the current nuclear design method has the sufficient accuracy for evaluating the partially plutonium loaded core. (auth)

17352 (NEDC-10796) PLUTONIUM UTILIZATION IN BOILING WATER REACTORS, PHASE II. Semiannual Report, January – June 1972. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept). Jan 1973. 98p.

For Edison Electric Inst., New York.

Big Rock Point irradiations of 230 fuel rods have continued to peak burnups of 27,500 MWd/t with no apparent problems. Site examinations and sipping tests during the March 1970 outage indicated good performance, although surface deposits as thick as 14 mils were observed through profilometry. There continue to be no defects in any of the mixed-oxide rods fabricated for Big Rock Point. All three of the 68-rod fuel assemblies and two rods from the 32-rod program were moved from low power positions in Cycle 9 to high power positions in Cycle 10, hence increasing the severity of the irradiation and increasing the probability of future failure. Two Big Rock Point annular pellet

rods with peak Big Rock burnups of 15,000 and 17,600 MWd/t were nondestructively examined in the VNC hot cells and prepared for ramp tests in GETR. One of the rods survived the first 2 ramps to 16 and 17 kW/ft with no indication of failure. Dosimetry measurements were made on the Task A-3 rods to determine radiation levels and monitor the effects of Am-241 buildup. It was concluded that the uranium rods which surround the MO_2 rods in the BWR interchangeable island design Pu recycle assemblies will be effective in providing assembly site handling shielding of a large percentage of the AM-241 gammas. Safeguards, accountability, and scrap recovery for the EEI scrap and fuel in storage at VNC are described. As part of the Task B efforts new explicit mathematical indifference methods were developed for representation of the costs of Pu recycle versus sale, Pu recycle versus Pu storage, and Pu sale versus Pu storage. Conclusions from the program indicate that the test irradiations are proceeding successfully with good performance, no failures, and peak burnups of 30,300 MWd/Mt; the interchangeable plutonium recycle bundle design objective has been accomplished with acceptable performance, economics, and safety; the annular fuel pellet concept continued to show promise as the most economical design for plutonium recycle in boiling water reactors; and there is considerable potential for improvement of plutonium values in the BWR through continued optimization. (auth)

17353 PREDICTION OF 3-D CORE POWER DISTRIBUTIONS IN LWR. Boerresen, S. (Institutt for Atomenergi, Kjeller, Norway). (1973). vp.

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

The program PRESTO is described which successfully computed 3-dimensional distributions of power density and coolant condition for given reactor operating data. (GE)

17354 FUEL ELEMENT END SEAL. Amon, F.; Hoechel, J. (to Licentia Patent-Verwaltungs GmbH). German Patent 1,564,280. 19 Feb 1970. Filed date 19 Aug 1966. 10p. (In German).

A fuel element end seal for the connecting of an external jacket with an internal jacket is described for fuel tubes in boiling superheated reactors. The external jacket consists of a material different from that of the internal jacket. The material of the external jacket has a smaller expansion coefficient than the internal jacket. The connection piece is constructed so that the material with the larger expansion coefficient is brought over that of the material with the smaller expansion coefficient. Between the internal jacket and the connection piece there is a heat insulation gap. The connection piece forms the extension of the external jacket. Only one tube section of the connection piece is deformed. The connection piece can also consist of two undeformed concentric tubes of which the internal connection piece is welded across with the external fuel jacket. (JSR)

17355 FUEL ELEMENT BUNDLE END PIECE. Friedrich, W. (to Licentia Patent-Verwaltungs GmbH). German Patent 1,564,256. 15 Jan 1970. Filed date 15 Apr 1966. 10p. (In German).

The end piece of a fuel element bundle is described. In the frame of the end piece slots of different length are arranged for the spacing of the fuel rods. Plate crosspieces of different height are introduced in these windows. At the intersection of the crosspieces the fuel rods with their plugs are inserted. A bracing of the lattice at the intersection occurs by springs on the fuel rods. The bracing is done by a brace nut or bolt which is screwed in a central threaded hole or on an outside screw thread on the fuel plug. The end plug of the central rod of a fuel bundle or its bracing nut or bolt has a tab for manipulation during fuel element exchange. The grating is secured by slipping the fuel element over the frame of the end piece and attaching it. (JSR)

17356 OFF-GAS RELEASE MANAGEMENT IN NUCLEAR POWER PLANTS. Charcoal Bed Type Rare Gas Hold-up System. Itakura, T.; Hashimoto, T.; Meguro, Y. (Japan Atomic Power Co., Tokyo). Kuki Seijo; 10: No. 2, 16-22(Jun 1972). (In Japanese).

The design and performance of a rare gas hold-up system at Tsuruga power plant (357 MW(e) BWR plant operated by JAPCO) are described. The system comprises 8 adsorbing towers with charcoal, the total weight of which is about 23 tons, and is designed for the gas flow of 20 m^3/hr and for the hold-up time of 20 days for Xe. This system is serially connected to an existing decay tank. Operation started in December 1971, 21 months after the beginning of commercial operation of the plant. Preliminary tests were performed with the gas flow of about 20 m^3/hr. The hold-up time for Kr and Xe was 52 hours and 44 days respectively, in actual load test. Whereas actual records as of March 1972 show that the gas flow is only 3 m^3/hr, and that the hold-up time is 350 hours and 290 days for Kr and Xe, respectively. It is estimated that radioactivity of rare gases is decreased by the factor of 1/1,000 ~ 1/10,000 through this hold-up system. It is also estimated that the present hold-up system is about 300 to 800 times as effective as the conventional decay tank for decreasing the radioactivity of rare gases. (JA)

17357 RADIOACTIVE RARE GAS HOLDUP SYSTEM. Murata, T. (Hitachi Ltd., Ibaraki, Japan). Kuki Seijo; 10: No. 2, 55-62 (Jun 1972). (In Japanese).

In BWRs, an activity reduction method for short-lived radioactive rare gases in effluent gas has been adopted, in which they are stored for 24 hours after pressurizing them in tanks. If off-gas is passed through adsorption columns filled with activated carbon, the rare gases are reversibly adsorbed in the activated carbon columns, held up in it for a period, and the short-lived rare gases decay during that period. This is the rare gas hold-up system. Though K value is different according to activated carbon properties, it also varies with temperature, pressure, flow rate, and coexisting gases (e.g., water vapor). A theoretical number of plates N of the columns is significantly influenced by gas flow speed. A prototype hold-up system of practical scale was manufactured and performance tests were conducted. The rare gas hold-up system is evaluated as an excellent activity reduction system for the radioactive rare gases mainly composed of Xe-133. (JA)

17358 METHOD AND MEANS FOR FUEL EXCHANGE IN A NUCLEAR REACTOR. Van Santen, A.; Elofsson, K. (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,733,250. 15 May 1973. Priority date 2 Dec 1969, Sweden. 16p.

A nuclear reactor formed of fuel assemblies of parallel fuel rods arranged, which are freely extractable and insertable at one end of the fuel assembly, is refueled by extracting from one of the fuel assemblies a number of fuel rods substantially less than the total number of fuel rods and replacing these by inserting new fuel rods into the vacated positions. This is done for a majority of fuel assemblies of the reactor. At the next refueling operation different fuel rods from those previously replaced are removed and replaced. The removal and return of the rods is produced by a tool having a plurality of gripping members capable of engaging shoulders beneath heads formed on the upper ends of the fuel rods. This may be accomplished by providing a tool having a number of gripping members attached to the tool body corresponding to the lattice positions of the fuel rods to be extracted, having gripping members which can be pushed together to grip beneath shoulders on the upper ends of the fuel rods. (Official Gazette)

17359 AEC STUDY ON THE DENSIFICATION OF NUCLEAR FUEL. Com. Naz. Energ. Nucl., Notiz.; 19: No. 2, 80-82(Feb 1973). (In Italian).

An account of a study conducted by the AEC on the densification of the nuclear fuel used in LWR's is presented. This study was started in May 1972 after the flattening of small sections of the unpressurized fuel rods in the Ginna Plant reactor. (auth)

17360 MANUFACTURING PLANS, CONCEPTS, AND FACILITIES FOR FLOATING NUCLEAR PLANTS. Turner, J. E. Nucl. Eng. Int.; 18: No. 205, 487-490(Jun 1973).

The shipyard-like facilities of Offshore Power Systems will allow floating nuclear plants to be built on an assembly line basis. Advantages in manufacture will then result from standardization, mechanization, modular assembly and systematic control. The manufacturing facility is described. Training of personnel is discussed. (UK)

17361 LONG-TERM ELECTRICITY PROGRAMME AND THE ROLE OF NUCLEAR POWER IN JAPAN. Ipponmatsu, T. (Japan Atomic Power Co., Tokyo). Nucl. Eng. Int.; 18: No. 206, 542-544 (Jul 1973).

The outlook for nuclear power in the Japanese long term electricity programme is discussed. Energy requirements for the period 1970 to 1985 anticipate a nuclear generating capacity of 60,000 MW(e) by 1985. The development and operating history of Japan's nuclear power plants are reviewed. Reference is made to problems of safety and siting and the outstanding future problems of enriched U demand and increasing amounts of radioactive waste. (UK)

17362 NUCLEAR-REACTOR STRUCTURE. Schilling, F. (to Siempelkamp Giesserei KG). U. S. Patent 3,734,827. 22 May 1973. Filed date 5 Jan 1970. 8p.

A nuclear-reactor structure is described in which the reactor core is housed in a metallic enclosure serving as a pressure vessel and as a radioactive shield. The walls of the structure are made of prestressed cast-iron bodies which may have interfitting

or interlocking formations with any gaps filled by pressure-retaining compounds. Stressing may be effected by rods or cables running through the cast-iron elements or by externally positioned cables, wires, bands, or rings. (Official Gazette)

17363 CHARCOAL BED SYSTEM FOR THE TSURUGA NUCLEAR POWER STATION. At. Jap.; 16: No. 9, 26-31(Sep 1972).

In the Tsuruga power station of Japan Atomic Power Company (BWR, 357 MW(e), started up in March 1970), a noble gas hold-up system using charcoal beds was introduced in December 1971. The system has reduced the discharge of radioactive off-gas to one hundredth of what used to be discharged—much lower than the level usually specified by regulations. Operation of the system is generally as follows: off-gas flux 3 N m^3/hr, temperature in the charcoal bed 15°C, operational pressure 0.9 atm, and charcoal weight about 23 tons. The experiences gained on Kr-85, Xe-133, and other aspects are described, as well as an assessment of the system. (JA)

17364 DEVELOPMENT OF REACTOR FEED PUMPS FOR 784MW BWR NUCLEAR POWER STATION. Onoda, T. (Hitachi Ltd., Tokyo). Hitachi Hyoron; 54: No. 12, 1093-1096(Dec 1972). (In Japanese).

Reactor feed pumps for use with multistage turbine pumps, with a barrel casing driven by a 2-pole induction motor, are used for up to 540MW BWR nuclear power stations. When station capacity is over 784MW, however, reactor feed pumps of the single stage, double suction impeller type are favored because of their compact construction. The suction pressure of the reactor feed pump is extremely high as compared with boiler feed pumps and the peripheral speed of the single suction pump impeller is large. A reactor feed pump to be used for 784MW BWR nuclear power plant was designed and fabricated. Tests of this pump could confirm its high reliability and obtain valuable data on design. Through the experience and data obtained the manufacture of even larger feed pumps with equally high reliability can be obtained. (auth)

17365 ASPECTS OF TWO-PHASE, GAS-LIQUID, SEPARATION RELATED TO NUCLEAR STEAM SUPPLY SYSTEMS. Prins, C. A. Delft, Netherlands; Technische Hogeschool (1971). 208p.

Thesis.

Steam–water separation in nuclear boilers (Boiling Water Reactors and Pressurized Water Reactor steam generators) constitutes a technical and economical problem increasing with unit size, where compaction, a high efficiency and a low pressure loss are determining factors. Inadequate separation has two aspects, carry-over of water with the steam to the turbine and carry-under of steam with the recirculating water. The carry-under problem was investigated following the usual division in primary and secondary separation with gravity and mechanical separation investigated as forms of primary separation. The test loop, designed for steam–water gravity separation experiments under actual reactor conditions (70 and 50 bar), incorporates a riser (two diameters are used: 0.125 and 0.152 m), an annular downcomer and forced circulation, while the steam is raised outside the loop in a separate boiler. The principal experimental data obtained are quality and void fraction in the downcomer, measured for riser qualities in the range of 4 to 20% at superficial downcomer water velocities up to 0.5 m/s. These results are presented in graphical form for three riser steam flow rates and three different levels above the riser at 50 and 70 bar pressure. A second experiment of exploratory nature concerns axial upcomer separators with a converging-diverging vortex tube and comprises the measurement of separation efficiency and pressure drop. A lucite test loop and the use of air and water permit the additional measurement of the radial distribution of the void fraction at several heights in the vortex tube. The experiment aims at investigating some fundamental aspects of the flow problems related to this particular separator type, which is chosen for its compactness, rather than at results for direct use on an industrial scale. An attempt was made to formulate a two-dimensional mathematical model describing the behavior of two-phase mixtures in the vortex tube of the separator. The model is generated in two versions. First a one-dimensional model is derived based on the conservation of mass and momentum, for the purpose of quantitative determination of the interaction forces. The auxiliary experiments required are described. Radial void fraction distributions of air–water mixtures flowing through a variable area channel were measured by means of a γ-attenuation technique at 9 locations in the channel, from which the axial distribution of the average values was derived. Comparing this distribution and that of the pressure in the channel with the model predictions the interaction forces were determined by trial and error as a function of the void fraction. The experiments were carried out for superficial water velocities of 1, 2 and 3 m/s and superficial air velocities of 0.5 to 3 m/s and two converging channels: from 0.1 to 0.07 and from 0.1 to 0.05 m. The two-phase wall friction of air–water mixtures was measured in a circular channel of 0.1 m diameter. A method for direct determination of the wall shear stress was used which measures the shear force exerted on an independently suspended section of the channel. Test loop characteristics restricted these experiments to the range of superficial water and air velocities of respectively 0.8 to 2.2 and 0 to 0.88 m/s. The experimental results are compared with predictions according to the correlations due to Martinelli and Levy. The second version of the model consists of the conservation laws of mass and momentum applied to the two-dimensional case of rotational symmetric flow, incorporating the empirical relations for the interaction forces determined previously. A method of solution for the set of equations, based on the so called N-strip method was derived. However, this course appears to lead to numerical instability. Possible causes are discussed as well as probable solutions to this deadlock. For the carry-under problem a simplified model based on the one-dimensional conservation laws is given making use of the experimental results of the gravity separation experiments. A comparison is made between downcomer quality and void fraction predicted by this model with the experimental data. In the range of incipient carry-under the agreement is good; at higher circulation velocities deviations occur, which are connected with the small scale of the experiment. A comparison is given with experimental carry-under results from the Dodewaard boiling water reactor as well as a prediction of the carry-under that would occur in the steam generators of the Stade station, if gravity separation were to be employed. (auth)

17366 NUCLEAR POWER: STATUS AT THE END OF 1972 AND MEDIUM-TERM FORECAST. Com. Naz. Energ. Nucl., Notiz.; 19: No. 4, 25-40(Apr 1973). (In Italian).

The evolution of worldwide nuclear power plants in 1972 is analyzed. Medium-term forecasts on future plants are included. (auth)

17367 THERMOGENE, AN INTEGRAL TRANSPORT PROGRAM FOR ARBITRARY X–Y GEOMETRY SYSTEMS. Part 1. Basic Theory of Program and Calculated Results. Janssen, A. J.; Caspers, C. M. (Interuniversitair Reactor Instituut, Delft, Netherlands). Atomkernenergie; 21: No. 1, 27-35(1973).

A thermal two-dimensional integral transport code has been developed which can handle fuel lattices such as used in the PWR and BWR at essentially any desired accuracy. The cross-sectional area of the lattice may be divided in regions by straight lines or circles in an arbitrary manner. Only the parameters of these lines and circles need be supplied by the user. The program itself provides for a systematic numbering and identification of the regions. The program has options for 1) three types of cluster boundaries, 2) isotropic and linear anisotropic scattering, 3) two neutron transport models between regions based on a flat-flux or a point-flux approximation. The basic theory of the program is given and the sensitivity to region size, transport- and scattering models is discussed. Also a comparison is made between THERMOGENE results and those obtained with the diffusion program EXTERMINATOR 2 and the S_N-program SFINX. (NE)

17368 380 kV SWITCHGEAR FOR THE PHILIPPSBURG NUCLEAR POWER STATION. Kriechbaum, K. (Allgemeine Elektricitaets-Gesellschaft, Kassel, Ger.); Kulik, P.; Stober, E. Elektrizitaetswirtschaft; 72: No. 6, 139-147(1973). (In German).

The Badenwerk AG and the Energie-Versorgung Schwaben AG are cooperating in building a nuclear power station in Philippsburg. This power station must be well connected in the integrated system. This means that a connection must be made to the 380 kV system of the Badenwerk and also to the 380 kV network of the Energie-Versorgung Schwaben. In the design of the installation, safety measures played a decisive role. Even a serious fault in the installation must not result in the loss of the block-unit capacity. This was taken into account in the design of the switchgear in Philippsburg which is described. (GE)

17369 ANALYSIS OF TRANSIENT TESTS OF FUKUSHIMA-I NUCLEAR POWER STATION. Seko, T. (Tokyo Electric Power Co. Inc.); Enomoto, T.; Tanabe, A.; Amano, T. Nippon Genshiryoku Gakkaishi; 15: No. 3, 184-190(Mar 1973). (In Japanese).

Transient tests for nuclear power plants are performed during the startup tests before commercial operation. Through these tests, plant stability, power control characteristics, and transient responses to various trips of equipment are demonstrated. Six typical tests conducted at the Fukushima Nuclear Power Plant No. 1 were chosen in order to compare the test data with analytical results. All available plant data have been incorporated into our analyses to obtain a strict comparison. Good agreement between the tests and the analytical results are proof of the validity of the analytical model of the BWR plant transients. (auth)

17370 FUEL CYCLE OF LIGHT WATER NUCLEAR POWER PLANTS. Balogh, E. Energ. Atomtech.; 26: No. 5, 230-237(May 1973). (In Hungarian).

The capacity of the world's nuclear power plants expected in the near future according to main types of reactors is surveyed. The fuel cycle of light water reactors is described including up-to-date technical and economic questions of these power plants. The price factor at each stage of the fuel-cycle related to the unit-weight of uranium in the finished fuel-bundle is discussed. (auth)

17371 COMPLETION OF LARGE SIZE CIRCULATING WATER PUMPS FOR FUKUSHIMA NUCLEAR POWER STATION UNIT-2, TOKYO ELECTRIC POWER CO., INC. Hayashi, H. (Ebara Mfg. Co. Ltd., Tokyo). Ehara Jiho; No. 81, 2-5(Sep 1972). (In Japanese).

The size of circulating water pumps is becoming larger with the increase of the capacity of power generating turbines. As the pumps grow in size, problems in design and manufacture that have not been seen in the manufacture of medium and small pumps in the past appeared, namely, as the pump components have to be enlarged; various reviewing is required for their design, manufacture, conveyance, assembly, installation, and factory performance testing. The circulating water pumps for Unit-2 (output 784 MW) at Fukushima Nuclear Power Station, TEPCO are described. (auth)

17372 FINLAND'S NUCLEAR POWER PROGRAM: THE LOVIISA AND OLKILUOTO PLANTS. Com. Naz. Energ. Nucl., Notiz.; 19: No. 4, 61-66(Apr 1973). (In Italian).

Some data on Finland's present and future power comsumptions, followed by a description of the Loviisa and Olkiluoto Power Plants, are presented. (auth)

17373 FILLING CENTERING DEVICE FOR POWDER-FILLED HOLLOW FUEL RODS. Herchenroeder, R. (to NUKEM Nuklear Chemie und-Metallurgie GmbH). German Patent 1,564,418. 12 Feb 1970. Filed date 16 Jul 1966. 5p. (In German).

The method and a device are described for axial centering of the internal tubes of tubular fuel rods for boiling superheated reactors. A radial spacer container fixed to an auxiliary tube moves slowly from above during filling with powder so that it is constantly at the upper boundary of the powder chute. (JSR)

17374 STRUCTURAL AND LAYOUT CONSIDERATIONS FOR NUCLEAR POWER PLANT IN HIGH SEISMIC AREA. Mulay, J. N.; Wahl, H. W. (Bechtel Power Corp., San Francisco). Combustion; 44: No. 12, 17-24(Jun 1973).

The effect of high seismic ground accelerations on the structure and layout of a two unit (1100 MW each) Boiling Water Reactor (BWR) nuclear power plant is discussed. It is shown how the technical feasibility of designing a plant for high ground acceleration was enhanced by changing the containment concept. (auth)

Power Reactors, Non-Breeding, PWR-Type

Refer also to abstracts 15265, 15516, 15976, 17351, 17353, 17359–17362, 17365–17367, 17370, 17372, 17501, 17502, 17520, 17545, 17547, 17614, 17617, and 17636.

17375 (BMFT-FBK-73-7) DEVELOPMENT AND INVESTIGATION OF ARRANGEMENTS FOR DETERMINING POWER PEAKS IN THE CORE BY MEANS OF STATIONARY FLUX DETECTORS. Klar, E.; Seidelberger, H.; Bauer, H. (Siemens A.G., Munich (West Germany)). Apr 1973. 28p. (In German). Dep. NTIS (U. S. Sales Only) $3.50.

In large pressurized water reactors, flux detectors are built into the core for the purpose of evaluating the flux distribution and measuring local flux peaks. Investigations were performed on multi-finger assemblies, gamma thermometers, gamma chambers, miniature fission chambers, and n-β detectors. The results show that n-β detectors are the most appropriate. In the future therefore, preference is to be given to n-β detectors, using the aeroball system for determining the power density distribution and calibrating the core detectors. (auth)

17376 (WCAP-3385-35) SAXTON PLUTONIUM PROJECT QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31, 1973. Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). May 1973. Contract AT(11-1)-3044. 21p. Dep. NTIS $4.00.

Data from the destructive examinations of end-of-life fuel rods from Core III in the Saxton Reactor are presented. The examinations included fuel and clad metallography and clad hydrogen analysis. (JWR)

17377 (WCAP-7160(Vol.1)) ECONOMIC UTILIZATION OF PLUTONIUM IN PRESSURIZED WATER REACTORS. Final Report. (Westinghouse Electric Corp., Pittsburgh, PA. Nuclear Fuel Div.). Feb 1968. 39p.

The activities reported consisted of parameter studies to determine the pertinent characteristics of reactor cores under various modes of recycle; fuel engineering studies to determine the relationship between the fabrication costs for uranium and plutonium fuel; and fuel cycle studies in which these results were combined with projected economic and operational data to yield plutonium value and fuel cycle costs over a broad range of reactor operating conditions. Two topics were selected for more detailed study and evaluation. These were directed toward improving the accuracy of plutonium reactor physics calculations and toward obtaining a better understanding of the characteristics of plutonium-fueled reactors. The work performed was directed toward determining the economic and technical factors affecting plutonium recycle. The program results are summarized. (HDR)

17378 (WCAP-7912) TOPICAL REPORT POWER PEAKING FACTORS. McFarlane, A. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div). Mar 1972. 69p.

Information is provided on the design constraints on peak local power density in a Westinghouse PWR, on the values obtainable with established and revised operating procedures, and on the measures taken to preclude exceeding design limits. Background information on the definitions and meaning of design bases related to power distribution is given. The steps to guarantee meeting design limits at all times are described. A total peaking factor F_Q of 2.40 (F_z = 1.55) at full power can be met in all anticipated plant maneuvers and this criterion cannot be violated even by operator control. (FS)

17379 FRACTURE AND SAFETY ANALYSIS OF NUCLEAR PRESSURE VESSELS. Bartholome, G.; Miksch, M.; Neubrech, G.; Vasoukis, G. (Siemens AG, Erlangen, Ger.). Eng. Fracture Mech.; 5: No. 2, 431-446(Jun 1973).

From symposium on fracture and fatigue; Washington, DC (3 May 1972).

An evaluation of the safety factors of nuclear reactor pressure vessels for pressurized water reactors to resist fracture is an important feature in ensuring nuclear reactor safety. The safety analysis has to demonstrate that there is no danger of failure at all. By means of brittle and ductile fracture mechanics the safety factors against critical stress, critical crack size and critical stress intensity factor are shown. The linear, elastic and plastic stress distributions for plane stress and plane strain conditions are derived for the different modes of fracture. A critical analysis of crack growth and of stress corrosion cracking extends the use of fracture mechanics. A comparison between stress intensity factors obtained by analytical computation and by the finite element method for the case of emergency core cooling is shown. Some technical applications as the estimation of critical crack sizes, the evaluation of operating performance and undercladding cracks are briefly discussed. (auth)

17380 GLOBAL HYDRAULIC INSTABILITY IN THE VESSEL OF A PRESSURIZED-WATER REACTOR. Daubert, A.; Pugnet, L.; Boulot, F. (Electricite de France, Chatou). (1972). vp.

From symposium on flow-induced structural vibrations; Karlsruhe, Germany (14 Aug 1972).

An account is given of an investigation of the hydraulic instability phenomenon in the annular space between the thermal shield and the reactor vessel. One result of the investigation is that the instability is caused by the thermal shield. The influence of the various geometric parameters is investigated: the mean diameter, the position of the shield, and other parameters which are less important. (GE)

17381 IMPROVEMENTS TO THERMAL POWER PLANTS, IN PARTICULAR OF THE NUCLEAR TYPE. (to Societe Babcock Atlantique). French Patent 2,116,671. 21 Jul 1972. Filed date 3 Dec 1970. 12p. (In French).

Thermal installations producing mechanical energy (in particular pressurized water reactors) are considered. An improvement is proposed in which the dried vapor coming from the high pressure part of the turbine is reheated by heat exchange with pressurized water obtained from the vapor generator and not with the vapor. (FR)

17382 FUEL-HANDLING MACHINE FOR LOVIISA I. Kosunen, S. (Finnatom, Helsinki). Nucl. Eng. Int.; 18: No. 205, 491-493 (Jun 1973).

The Valmet fuel handling machine for the Finnish PWR reactor Loviisa I incorporates several novel features. It performs a wide variety of functions within both the reactor and the refuelling pond and may be considered as a maintenance and service machine. These functions are described and details are given of the construction, design parameters and operation under computer control. (UK)

17383 SITE RELATED DESIGN FOR THE ATLANTIC GENERATING STATION. Ashworth, J. A. (Public Service Electric and Gas. Co., Newark, NJ). Nucl. Eng. Int.; 18: No. 205, 483-486 (Jun 1973).

Special features of the offshore generating station include the breakwater and the transmission cable leading to land based switching stations. The design and construction of the breakwater are briefly described and reference is made to the type of mooring. Site related work includes analysis of the ecological effects. Two sets of design conditions for transmission cable are outlined one for the flexible cable from the floating plant to the breakwater and the other for the stationary buried lines. (UK)

17384 ATLANTIC GENERATING STATION. Kehnemuyi, M. (Public Service Electric and Gas Co., Newark, NJ); Nichols, R. C. Nucl. Eng. Int.; 18: No. 205, 477(Jun 1973).

The Atlantic generating station to be built off the New Jersey coast will be a 2300 MW(e) facility incorporating floating nuclear power plants. A brief outline is given of the development of the concept and of the licensing procedures. (UK)

17385 NUCLEAR REACTOR ORGANIZATION AND FUEL ASSEMBLY ARRANGEMENT. Notari, G. V.; Rickert, R. J. (to Combustion Engineering, Inc.). U. S. Patent 3,725,199. 3 Apr 1973. Filed Date 9 Apr 1969. 6p.

A fuel assembly for a nuclear reactor cooled by a moderating fluid is described. The assembly has flow tubes that extend beyond the inlet of the assembly and provide positioning and support structure when the assembly is mounted in the reactor. Flow is regulated through the flow tubes by orifices upstream of these tubes. (Official Gazette)

17386 NUCLEAR CONTAINMENT SYSTEM. Harstead, G. A.; Locante, J.; Russell, J. G. (to Westinghouse Electric Corp.). U. S. Patent 3,725,198. 3 Apr 1973. Filed Date 3 Apr 1969. 6p.

A containment structural system described consists of a sealed inner pressure containing shell, preferably of steel, and an outer cylindrical shell, preferably of concrete, spaced therefrom and built on a common base. The space between the shells is filled with a fluid such as water so that the fluid entirely covers the inner shell to provide radiation shielding and to assist in carrying pressure forces in the event of a loss of coolant accident. (Official Gazette)

17387 FLOATING NUCLEAR PLANT DESIGN. Collier, A. R.; Nichols, R. C. Nucl. Eng. Int.; 18: No. 205, 478-483(Jun 1973).

The design of the floating nuclear plant for the Atlantic generating station to be built off the New Jersey coast will use as a reference a well known but technically advanced Westinghouse nuclear steam supply system. The necessary standardization and licensing features are already known and therefore will allow the manufacture of large numbers of units. The design features dependent upon it being placed on a floating platform in the ocean include weight and space considerations, watertightness and storm protection, and operator/crew needs. A special feature is the platform trim system to adjust for changes in plant trim due to movement of large loads around the plant. (auth)

17388 PWR PRACTICE IN THE UNITED STATES AND EUROPE. Abbott, W. E.; Chernock, W. P.; Braun, W.; Martin, A. Combustion; 44: No. 12, 25-31(Jun 1973).

Important factors relating to PWR practices in the United States and Europe are compared. Included in this review are environmental factors which include procurement, construction, standardization, quality assurance, licensing and safety-related matters; plant design practice which concentrates on standards and codes; fuel practice; and research and development. (JWR)

Power Reactors, Non-Breeding, Graphite Moderated

Refer also to abstracts 17362, 17366, 17579, and 17623.

17389 (JUL-937-RG) STUDIES ON THERMODYNAMIC TRANSIENTS IN THE CORE OF A HIGH-TEMPERATURE REACTOR. Singh, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar 1973. 139p. (In German). Dep. NTIS (U. S. Sales Only) $9.00.

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

Transients in high temperature gas turbine and process heat reactors in connection with afterheat removal and with power changes were studied. A suitable calculating model for the solution of these problems is given, which is based upon unsteady heat conduction in the fuel elements and quasi one-dimensional flow in the cooling medium circuit. For the gas turbine plant parameter, studies with the two afterheat removal systems were done which are based upon natural and forced convection and use the water-cooled liner for the heatsink. The natural convection for the afterheat removal for all high-temperature reactors is not an ideal solution, because in the cooled upper half of the core a high temperature rise due to the reversal of flow and the temperature equalization takes place which is dangerous for the steel components. Also, one comes to the conclusion that an amount of about 1.5% of the thermal reactor power must be removed with the forced convection after reactor shutdown, when an increase of the maximum temperature in the core of less than 100°C has to be granted. Moreover these studies show that a recuperative heat exchanger in the circuit of afterheat removal system is not an absolute necessity. For the process heat plant calculations have been done to show whether a primary circuit under definitely given conditions for the after heat removal is sufficient when a break of the concentric duct between core and heat exchanger takes place. The studies show that with the protective gas N_2, the afterheat removal with the available primary circuit even by system pressure of 1 bar is possible when the following conditions can be fulfilled: By the break of the concentric duct no flow separation before the core takes place; an increase of the maximum temperature in the core up to 70°C has been allowed; inset of the cooling within 20 min after reactor shutdown. Power changes on the turbine of gas turbine plant can be quickly accomplished through mass flow changes owing to the by-pass or pressure level control because of the sluggish thermal behavior of the core. (auth)

17390 OBJECTIVES FOR AN HTR R AND D PHYSICS PROGRAM. Johnstone, D. (Atomic Energy Establishment, Winfrith, Eng.); Scott, J. A. (1973). vp.

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

Important objectives for an HTR R and D program and the importance of particular characteristics for safety and reactor performance are discussed. The relationship between some important uncertainties and reactor design and operating costs is analyzed. To extrapolate to power reactor conditions, the need for a comprehensive computational scheme validated by an adequate experimental program is emphasized. The reduction in uncertainty as the theoretical and experimental reactor physics development proceeds is illustrated with respect to the UK's program in support of the low enriched HTR concept. The current situation for this concept is discussed and compared with that for the Th cycle HTR for which less zero energy experimental data are available. (GE)

17391 CRITICAL EXPERIMENT CESAR-2 AS A MODEL TO TEST NUCLEAR DATA SETS AND COMPUTER PROGRAMS FOR THE LAY OUT OF HIGH-TEMPERATURE REACTORS. Scherer, W. (Kernforschungsanlage, Juelich, Ger.). (1973). vp. (In German).

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

The tested programs give an exact record of the neutron-physical reactor behavior. Deviations due to different calculation methods (SN, P_{ij}) are low compared with discrepancies due to the library which include the determination of group cross-section sets in the resonance region. Deviations between experiment and theory do not arise in typical HTR fuel elements. It is, however, necessary to improve the nuclear data libraries, as was demonstrated by the uncertainties of the calculated and measured values for the extremely heterogeneous CESAR-2 fuel elements. (GE)

17392 GAS-COOLED PRESSURE-TUBE REACTOR WITH FUEL ELEMENTS CLAD BY GRAPHITE TUBES. Assmann, H. (to Siemens AG). German Patent 1,564,640. 12 Feb 1970. Filed date 24 Jun 1966. 11p. (In German).

A gas-cooled pressure-tube reactor with fuel elements clad by graphite tubes is described. A number of fuel rods containing the fuel material are fastened hanging from rod holders consisting of rod guard rings and grids. The rod guard rings and grids have a rated breaking point, and at the lower end of each pressure tube arresting gear is arranged for catching fuel elements released from the mounting support. The rated breaking point is formed by cross section narrowing at the connection site between rod guard rings and grids. The arresting gear consists of an external cylindrical collector which is arranged over the lower shield of the pressure tube or the coolant channel and is provided with a central conical borehole. The upper diameter of this bore hole is larger than the fuel element diameter without cladding tubes and its lower diameter is smaller than the diameter of the fuel elements joined together. (JSR)

17393 MACHINE FOR CHARGING AND DISCHARGING A HIGH TEMPERATURE NUCLEAR REACTOR WHILE IN OPERATION. Felten, P.; Gros, G.; Vivien, J. (to Commissariat a l'Energie Atomique). French Patent 2,128,143. 20 Oct 1972. Filed date 8 Mar 1971. 14p. (In French).

A machine for charging high temperature nuclear reactors having piles in the form of adjacent vertical column cells consisting of superimposed prismatic blocks is described. The axis of symmetry of each cell coincides with the axis of a well in the roof of the reactor. The machine moves above the roof of the reactor and can be connected to the roof in a leaktight manner above each well. The machine enables any of the cell columns to be replaced by a column of new blocks while the reactor is in operation. (FR)

17394 MECHANICAL DESIGN OF TRISO-COATED PARTICLE FUELS FOR THE LARGE HTGR. Gulden, T. D.; Smith, C. L.; Harmon, D. P.; Hudritsch, W. W. (Gulf General Atomic Co., San Diego, CA). Nucl. Technol.; 16: No. 1, 100-109(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

The performance of TRISO-coated carbide fissile particles, of the type to be used in the large HTGR, correlates well with statistically based calculations of stresses in the SiC coating. Three coated-particle batches, containing a total of nearly 10^4 individual coated particles, showed insignificant coating failure (≤0.2%) after exposure to essentially the most severe combined conditions of fast neutron exposure, burnup, and temperature to be experienced by fuel in a large HTGR. This high reliability derives from the fact that less than 1% of the particles in each batch had SiC tensile stresses greater than 30,000 psi, while the SiC layer in about 80% of the coated particles in each batch remained in compression throughout life. Two additional experimental batches of TRISO-coated carbide fissile particles had thinner coatings that resulted in higher mean SiC stresses in each batch and in probabilities of SiC coating stresses greater than 30,000 psi of 3.5 and 8.5%. This compares with the observed incidence of coating failure during irradiation to full design exposures of about 4% in both cases. These results provide further confirmation of the value of analytical stress models in interpreting the results of coated particle irradiation experiments, and emphasize the importance of a statistical approach to coated particle design. (9 figures) (auth)

17395 MATHEMATICAL DESCRIPTION OF SPHERE MOTION IN PIPELINES, PARTICULARLY IN THE FUELING MACHINE OF A PEBBLE BED REACTOR. Rysy, W. Forsch. Ingenieurw.; 39: No. 1, 29-34(1973). (In German).

From Newton's Law, equations are derived which indicate the time-dependent sphere velocity and the roll path of a sphere in an inclined pipe with a gas stream. A comparison with several experimental results (pipe diameter 65 mm, sphere diameter 62 mm) shows that the experimental values are in accordance with the theory in a wide velocity range of the gas stream. Various limiting cases are also investigated. (GE)

17396 APPLICATION OF ELECTRO-SLAG AND CONSUMABLE GUIDE WELDING. Part 2. Ellis, D. J.; Gifford, A. F. (International Combustion Ltd., Derby, Eng.). Weld. Metal. Fabr.; 41: No. 5, 161-166(May 1973).

Applications of electro-slag welding in gas-cooled reactors are described. They include welding of the dome of the shielding facility, the core restraint cylinder, and the stream generator shells of the Dungeness B reactor, welding of component structures such as shield walls and support columns for Wylfa, and welding of charge tubes and gas inlet nozzles for Sizewell. Examples are given of the use of electro-slag welding in the manufacture of plants for power generation. (UK)

17397 IMPROVEMENTS RELATING TO GRABS FOR HANDLING FUEL ELEMENTS. E.G., FUEL CARTRIDGES, OF NUCLEAR REACTORS. Briot, P. M. H. (to Groupement Atomique Alsacienne Atlantique). British Patent 1,311,180. 21 Mar 1973. Filed date 10 Nov 1970. 4p.

Reference is made to grabs for handling fuel elements within the channels of a reactor cooled by high pressure gas. The grab described has improved aerodynamic operation in conditions of gas currents of high flow rate and high pressure. The grab is provided with cowlings for each tong, streamlined to a bean shaped external curvature. Each cowling houses the greater part of the tong exposed below the grab body and is rigidly fixed to a lower portion of the grab body and to guiding ribs for the grab body. The guiding ribs extend beyond the cowlings and merge into a guard ring surrounding the cowlings. The guard ring is recessed at intervals along its underface to permit flow of gas when it bears against the upper edge of a fuel cartridge. (UK)

17398 NUCLEAR REACTOR. Marek, H.; Gnutzmann, H.; Fratzer, G. (to Brown Boveri Krupp Reaktorbau GmbH). German Patent 1,939,649. 25 Feb 1971. Filed date 4 Aug 1969. (In German).

A nuclear reactor, preferably with a cylindrical core and a spherical hopper arranged along the axis of the core and with a charge of spherical fuel particles, is described. The regulation of the reactor is accomplished by means of absorbing rods. It is characterized by the fact that the core is enlarged to form chambers for the volume displaced by the spheres during the descent of the absorbent rods. (TSS)

17399 COMMENTS ON MERIT INDEX FOR GAS-COOLED REACTOR HEAT TRANSFER. Leslie, D. C. (Queen Mary Coll., London). Nucl. Sci. Eng.; 51: No. 1, 92-93(May 1973).

Merit index equations are given for the total rate at which heat is transferred to the coolant, pumping power, and cost of electricity. (FS)

17400 PRESSURE VESSELS FOR THE ADVANCED GAS-COOLED REACTOR. Burrow, R. E. D. (Taylor Woodrow Construction Ltd., Southall, Eng.); Williams, A. J. Kerntechnik; 15: No. 4, 167-172(1973).

The prestressed concrete pressure vessels for the Hartlepool and Heysham stations together with the associated developments are described. Components of the pressure vessels are discussed in some detail. The application of the podded boiler principle to the high temperature reactor is briefly mentioned. (GE)

17401 PROCESS TECHNOLOGY FOR A COMPOUND PLANT WITH A HIGH TEMPERATURE REACTOR FOR STEEL PRODUCTION. Ermisch, K. (Krupp Friedrische GmbH, Essen); Haehn, P. C.; Schafstall, H. G.; Seelig, H. F.; Keller, J.; Nitschke, E.; Kerntechnik; 15: No. 2, 80-89(1973). (In German and English).

The general consideration governing the design concept of a combined power generation and steel production plant are discussed. The process technology of gas generation and of the processing of ore into steel (orig.) are considered. (GE)

17402 REALIGNMENT OF REFUELING MACHINE RAILS IN NUCLEAR POWER PLANT. Ferencik, A.; Fordinal, V. (Engineering Geodesy, Bratislava). Geod. Kartogr. Obzor.; 16: No. 11, 274-277(1970). (In Slovak).

In 1968, realignment of the refueling machine rails was carried out in the A-1 nuclear power plant. The procedure and the results are described in detail. The railway is 73 meters long and is made up of two 7 by 17 cm rails made of special steel. (Nucl. Sci. Abstr. Czech.)

17403 SUBMERGED GAS-CIRCULATOR MOTORS FOR ADVANCED GAS COOLED REACTORS. Schwarz, K. K. (Laurence Scott and Electromotors Ltd., Norwich, Eng.). Proc. Inst. Elec. Eng. (London); 120: No. 7, 777-785(Jul 1973).

The historical background, development, design, and full-power full-pressure tests of submerged gas-circulator equipment rated 5 MW at 3000 rev/min for 11 kV, 50 Hz, 3-phase supply are described. The environmental requirements, due to the nuclear reactor, of 40 atm of CO_2 with operation down to 1 atm of air, need careful consideration from various motor-design aspects: aerodynamic, lubrication, dielectric, etc. The complex equipment requires the closest integration of design between the "mechanical" and "electrical" constructor as well as the reactor constructor, and illustrates several interesting and/or novel features. Brief mention is made of the impact of changing the environment to helium. (auth)

17404 SYSTEM ANALYSIS AND ECONOMIC ASPECTS OF A COMPOUND PLANT WITH A HIGH TEMPERATURE REACTOR FOR STEEL PRODUCTION. Ermisch, K. (Krupp Friedrische GmbH, Essen); Haehn, P. C.; Schafstall, H. G.; Seelig, H. F.; Keller, J.; Nitschke, E. Kerntechnik; 15: No. 3, 121-128(1973). (In German).

The main process parameters and problems of a steel production plant with a nuclear heat source, with particular emphasis on the plant concept, process technology, system analysis and economy are examined. (GE)

17405 HIGH TEMPERATURE REACTORS. Beckurts, K. H. (Kernforschungsanlage, Juelich, Ger.); Bergmann, B. Atomwirt., Atomtech.; 18: No. 4, 191-198(1973). (In German).

From annual meeting of Deutsches Atomforum; Bonn, Germany (29 Nov 1972).

In the past few years high temperature reactors (HTR) have attracted worldwide attention and are now looked upon as attractive alternatives to the light water reactors. They have a considerable potential for further development especially with the use of gas turbines in the direct circuit and for the generation of nuclear process heat at high temperature levels. The international situation of the HTR is characterized by varying fuel element concepts, par-

ticularly spherical and block forms. The focus of development lies in the Federal Republic of Germany and in the USA. The future of the HTR will be essentially influenced by the degree to which industry in European and worldwide collaboration succeeds in becoming so efficient that it can compete with the industrial firms offering light water reactors. (GE)

17406 DEVELOPMENT OF HIGH-TEMPERATURE REACTORS IN THE FEDERAL REPUBLIC OF GERMANY. Part 1. Schwarz, D. Energ. Tech.; 25: No. 4, 92-96(1973). (In German).

Since 1956, the main object of German research in the field of high temperature reactors has been the development of a pebble bed reactor. During 1961 and 1967, the test reactor was set up for this purpose in Juelich, and the construction of a 300 MW prototype reactor was begun in 1971 in Uentrop. The first commercial high temperature reactor should be constructed under American license where the main feature is block formed fuel elements. The new principal aim of German research and development is the coupling of a helium turbine with one of these two reactor construction types. Just how far this development is technically useful and economically purposeful is discussed in a series of three reports. The first report deals with a technical comparison of high temperature reactors with pebble and block shaped fuel elements; the second investigates the problem of whether the commercialization of pebble bed reactors is worthwhile despite the market technical disadvantages; the third compares the cost-use relationship of high temperature reactors and their possible applications. (GE)

17407 FAPIG AND ITS ACTIVITIES IN THE NUCLEAR FIELD. Kasaba, T. (First Atomic Power Industry Group, Tokyo). Nucl. Eng. Int.; 18: No. 206, 570-571(Jul 1973).

The First Atomic Power Industry Group (FAPIG) was formed to promote and construct nuclear power plants. One of the main activities is in the field of gas-cooled reactors and includes work on AGR's and the HTR. The group is also participating in national projects for the development of fast breeder reactors and advanced thermal reactors. The extent of co-operation in the development of Joyo, Monju, and the 165 MW(e) JATR reactor Fugen is indicated. (UK)

17408 INSTRUMENTATION FOR THE UK NUCLEAR PROGRAMME. Woodfine, N. I. (Plessey Co. Ltd., Poole, Eng.); Permain, A.; Vivian, D. Kerntechnik; 15: No. 4, 173-176(1973).

Specialized instrumentation has evolved in the U.K. with the construction of nuclear power stations which commenced in the mid 1950s. A number of reactor types are involved including not only the magnox gas cooled reactors and the AGR's but also prototype HTGR (Dragon), SGHWR and sodium fast reactor (PFR). Reactor safety circuits (protection), auto control and burst fuel element detection instrumentation are described. (GE)

17409 DIRECT CYCLE ELECTRONUCLEAR PLANT. Maillet, E. (to Commissariat a l'Energie Atomique). French Patent 2,128,111. 20 Oct 1972. Filed date 5 Mar 1971. 6p. (In French).

A method for integrating the entire direct cooling circuit of a nuclear reactor in a single vessel is proposed. Particularly compact gas turbine components joined by short circuits are grouped with heat exchangers in a circular or polygonal form hall provided in the vessel containing the reactor. Each of the essential components is either orientated radially or in the direction of the 3 to 6 principal peripheral openings and is demountable without displacing the other components. (FR)

17410 DEVICE FOR THE SELECTIVE WITHDRAWAL OF INDIVIDUAL SPHERES FROM A NUMBER OF SUPPLY MAINS CONTAINING DIFFERENT TYPES OF SPHERES. Schoening, J.; Landwehr, H.; Handel, H.; Beck, W. (to Brown Boveri Krupp Reaktorbau GmbH). German Patent 1,548,185. 16 Apr 1970. Filed date 15 Nov 1966. 16p. (In German).

A device for selective withdrawal of individual spheres from a number of supply mains containing different types of spheres is described. It is designed for use primarily in reactors with spherical elements. The device has a cylindrical housing into which the supply mains discharge and two coaxial movable plates arranged over and independent of each other. The upper one has an opening corresponding to the diameter of the spheres and the bottom plate one or several boreholes of the same diameter. There is a discharge pipe at the bottom of the housing. The supply main discharges into a free space over the upper plate. (JSR)

17411 HIGH TEMPERATURE GAS COOLED REACTOR DEVELOPMENT OUTSIDE THE UNITED STATES: A CONSULTANTS VIEW. Page, R. W.; Read, D. T. (Burns and Roe, Inc., London). Combustion; 44: No. 12, 32-36(Jun 1973).

Topics discussed include the current state of HTR development, the general features of the HTR concept, economics, and future trends for the HTR system. (JWR)

17412 TEMPERATURE-DEPENDENT k_∞ FOR A ThO_2-PuO_2 HTGR LATTICE. Newman, D. F. (Battelle Pacific Northwest Labs., Richland, WA). Nucl. Technol.; 19: No. 2, 66-83(Aug 1973).

The temperature dependence of k_∞ for a graphite-moderated ThO_2-PuO_2-fueled lattice has been measured in the High Temperature Lattice Test Reactor. Values of k_∞ measured at equilibrium temperatures from 20 to 1000°C serve as a benchmark for evaluating computational methods and cross sections used in the design of a plutonium-fueled high temperature gas-cooled reactor (HTGR). The calculated and measured changes of k_∞ with temperature are in agreement. However, the magnitudes of calculated values are ~0.8% higher than the measured values for k_∞. When plutonium is used as the initial fissile fuel, the temperature coefficient of reactivity is changed favorably from that of an HTGR lattice fueled initially with ^{235}U. The reactivity decrease associated with elevating this plutonium–thorium fuel to operating temperature is ~30% less than that obtained with $^{235}U-Th$ fuel, so the excess reactivity for which the control system must compensate is reduced with plutonium fueling. Above the operating temperature range, plutonium tends to make the temperature coefficient of the HTGR more negative due to increased neutron capture in the 1.06-eV resonance of ^{240}Pu. This effect will improve the self-limiting characteristics of the reactor during a power excursion. (auth)

Power Reactors, Non-Breeding, Otherwise Moderated

Refer also to abstracts 17366, 17408, 17523, and 17542.

17413 ASSEMBLIES OF JOINED PLATE CONSTRUCTIONS. Hewins, J. A. (to United Kingdom Atomic Energy Authority). British Patent 1,304,366. 24 Jan 1973. Filed date 5 Jun 1969. 5p.

Some tanks, such as reactor calandria tanks, are so large that transportation to site in one piece is impossible. Welding of sections on site is not considered satisfactory for calandria tanks, and bolted constructions are difficult to seal internally. In the arrangement described the sections are joined together by a drawbar having two movable collars for clamping across opposed faces of the sections. These collars provide frusto-conical sockets for frusto-conical spigots formed on the opposed surfaces of the sections arranged so that when the collars are clamped across the opposed surfaces of the sections to engage the spigots with the sockets the sections are urged together. The whole construction may comprise an assembly of tanks bounding an inner chamber, the tanks being joined by a number of spaced drawbars, located between adjoining sides of the tanks and extending between opposed faces. Sealing numbers are interposed between the tanks. The arrangement is particularly applicable to reactor heavy water calandrias, the outer tanks containing ordinary water and the inner chamber containing heavy water, with the tanks and inner chamber penetrated by calandria tubes. (UK)

17414 CIRENE PROTOTYPE. Broggiato, A. (CNEN, Milan); Casagrande, I.; Pedretti, A. Com. Naz. Energ. Nucl., Notiz.; 19: No. 3, 28-42(Mar 1973). (In Italian).

CIRENE is a heavy-water moderated, natural-uranium fueled reactor using evaporating natural water as a heat-transfer medium. The prototype is a 40-MW(e) demonstration reactor which is now being built under a CNEN-ENEL agreement with the participation of CISE and of the Italian nuclear industry. Design characteristics and specifications are presented. (auth)

17415 CIRENE RESEARCH AND DEVELOPMENT PROGRAM. Mancini, C. (CNEN, Milan); Villani, S. Com. Naz. Energ. Nucl., Notiz.; 19: No. 3, 43-82(Mar 1973). (In Italian).

A description is presented of the highlights of the CIRENE R & D activities, comparing the main results achieved in Italy with those obtained in other countries in the development of pressurized-tube, heavy-water moderated and lightwater cooled reactors. (auth)

17416 PROSPECTS OF UTILIZATION OF THE CIRENE REACTORS. Barabaschi, S. (CNEN, Milan); Castelli, G.; Silvestri, M. Com. Naz. Energ. Nucl., Notiz.; 19: No. 3, 83-90(Mar 1973). (In Italian).

The prospects of utilization of heavy-water reactors and the potential capabilities of CIRENE are described. (auth)

17417 METHOD OF DECONTAMINATING HEAVY WATER COOLED AND MODERATED REACTOR. Motojima, K.; Sakurai, H.; Onishi, H.; Sasaki, Y.; Koike, M.; Ueno, K. (to Japan Atomic Energy Research Inst.). U. S. Patent 3,737,373. 5 Jun 1973. Priority Date 2 Jul 1970, Japan. 4p.

A heavy water cooled and moderated reactor, its nuclear fuel

assemblies, attached pipings and container can be decontaminated by employing a heavy water solution of deuterated oxalic acid. The radioactive substances, reactor materials, and/or nuclear fuels eluted in the solution are removed by decomposing the deuterated oxalic acid by means of ionizing radiations. (Official Gazette)

17418 GENTILLY CANDU-BLW PLANT: INITIAL OPERATING EXPERIENCE. Com. Naz. Energ. Nucl., Notiz.; 19: No. 2, 85-88(Feb 1973). (In Italian).

The main characteristics of the Candu-BLW plant at Gentilly with particular reference to the experience gained in the first year of operation are reviewed. (auth)

17419 APPROXIMATE CALCULATION METHOD FOR DESIGNING THE CORE SUPPORT STRUCTURE OF A PRESSURE TUBE REACTOR. Cravarolo, L.; Zelger, P. (CISE, Segrate, Italy). Energ. Nucl. (Milan); 20: No. 5, 280-292(May 1973).

The stresses and strains in static-elastic conditions of the core support structure of the CIRENE prototype reactor are obtained by a simplified calculation method (CAESAR code) and are compared with the experimental values measured on a 1:5 scaled-down model of the structure. This calculation method proved to be applicable to the design of the core support structure of a pressure tube reactor, thanks to the satisfactory agreement between theoretical and experimental values. (auth)

Power Reactors, Breeding

Refer also to abstracts 15905, 15907–15910, 15914, 15915, 15949, 15950, 15960, 15967, 16046, 16048, 16050, 16104, 16106–16108, 17366, 17407, 17408, 17466, 17471, 17472, 17503–17505, 17525, 17529, 17535, 17546, and 17619.

17420 (AI-AEC-13061) FUELS, MATERIALS, AND CONTROL ROD DEVELOPMENT PROGRAMS. Quarterly Technical Progress Report, January–March 1973. (Atomics International Div., Canoga Park, Calif. (USA)). 15 May 1973. Contract AT(04-3)-824. 44p. AT $4.00.

The radiation effects on the mechanical properties of Type 316 stainless steel are studied. The effects of fast neutrons on the generation of helium in ^{10}B are measured. The design parameters and performance requirements for tantalum control rods for an LMFBR are described. (DCC)

17421 (AI-AEC-13062) SODIUM TECHNOLOGY AND COVER GAS SEAL DEVELOPMENT PROGRAMS. Quarterly Technical Progress Report, January–March 1973. (Atomics International Div., Canoga Park, Calif. (USA)). 15 May 1973. Contract AT(04-3)-824. 87p. AT $5.45.

The development and testing of components for a liquid sodium test loop are described. Cleaning and storage requirements for liquid sodium coolant loop components are presented. The friction test program for the analysis of materials for use in the FFTF cooling system is described. The testing of cover gas seals for LMFBR and FFTF cooling systems is reviewed. (DCC)

17422 (ANL-RDP-4) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL 1972. (Argonne National Lab., Ill.). 19 May 1972. Contract W-31-109-eng-38. 196p. AT $7.60.

Highlights of project activities for April 1972 are summarized. The EBR-2 operations and testing are reported. The development of FFTF instrumentation and fuel assemblies is summarized. Sodium impurity analysis and liquid sodium effects on stainless steels are presented. Studies of LMFBR fuels and materials, fuel cycles, physics, and safety are described. TREAT operations are reviewed. Performance testing of stainless steel clad PuO_2-UO_2 fuel elements is described. Thermal plume dispersion studies for Point Beach Power Reactor Unit 1 are summarized. (DCC)

17423 (BMFT-FBK-73-8) FINAL REPORT ON THE FEASIBILITY STUDY CONCERNING THE INSERTION OF A FAST CORE INTO THE COMPACT SODIUM-COOLED NUCLEAR FACILITY. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany); Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). Apr 1973. 56p. (In German). Dep. NTIS (U. S. Sales Only) $5.00.

A brief outline of the results of the feasibility study performed in connection with the proposed modifications to and operation of the KNK facility with a fast core is presented. The objective of this project is to fulfil the requirement originating from the development of the sodium-cooled fast breeder reactor, in that a test bed is needed for proof-testing fuel rod clusters and in-core instrumentation as well as for accumulating operating experience under largely representative SNR-300 conditions. The results of the feasibility study performed indicate that it is practicable to revamp the KNK facility by inserting a fast core. (auth)

17424 (GEAP-13931) DESCRIPTION AND EVALUATION OF THE FLUX LINKING APPROACH FOR COMPUTING THREE-DIMENSIONAL FLUXES: THE COMPUTER CODE TRIAL. Cowan, C. L.; Greebler, P.; Hutchins, B. A.; Kelley, M. D.; Protsik, R. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Mar 1973. Contract AT(04-3)-893. 64p. Dep. NTIS $5.45.

A technique was evaluated for the systematic application of two-dimensional flux sets to a three-dimensional reactor model. Such a technique would have application over a broad range of reactor studies where flux solutions are essentially limited to two dimensions, due to computational costs and computer capabilities. The technique has been programmed into a computer code named TRIAL. Computations on a three-dimensional reactor model with partially inserted control rods show that only a few percent error is introduced by the linking process in three-dimensional reaction-rate distributions obtained from selected two-dimensional flux sets. Such results are dependent on the user options chosen and this sensitivity is evaluated. Also described are the flux linking procedures, including the flow of calculations which are performed, the options which are available and the input instructions for TRIAL. (auth)

17425 (GU-5294) TOPICAL REPORT, FAST REACTOR MIXED CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM. High Power and Heat Flux Irradiation of Uranium–Plutonium Carbides. Montgomery, M. H.; Strasser, A. A.; Andersen, J. C.; Grando, C. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). Apr 1973. Contract AT(11-1)-3059. 60p. Dep. NTIS $5.45.

Twelve fuel rods containing high-density (UPu)C pellets were irradiated in the General Electric Test Reactor (GETR) Trail Cable Facility at a fuel surface heat flux of 660 W/cm^2 (2.1×10^6 Btu/hr-ft^2) and linear power of 1500 W/cm (45 kW/ft). The design parameters for the experiments are presented. All 12 fuel rods operated as designed without clad failure or increase in clad diameter. The fuel rods were uninstrumented and double-encapsulated with a NaK bond between the fuel rod and capsule. 5 references. (auth)

17426 (INIS-mf-240) PURPOSE OF THE BREEDER DEVELOPMENT. Memorandum of the Consortium SNR. (Internationale Atomreaktorbau G.M.B.H., Bensberg (West Germany)). Dec 1970. 36p. (In German). INIS.

The economical implications of the installation of breeder reactors, concerning the economical advantages of the breeder reactors themselves as well as their influence on the development of the costs of other primary energy sources (incl. uranium) is illustrated. An appendix gives the most important cost data, calculation examples for optimization in an integrated system, and considerations as to an optimum utilization of plutonium. Some remarks on the long-term outlook of the uranium market especially on the uranium price and cost advantages resulting from the use of carbide fuel are given. (INIS)

17427 (JAPFNR-105) ANALYSIS OF JOYO MOCK-UP EXPERIMENTAL DATA BY TWO-DIMENSIONAL GAMMA-RAY HEATING DISTRIBUTION CALCULATION CODE 2D-GAMM. Iwaki, T.; Seki, Y.; Osada, H. (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan)). Aug 1972. 36p. (PNC-J-72-18). Dep. NTIS (U. S. Sales Only) $4.00.

An analytical study of γ-ray exposure dose distribution as part of the JOYO mockup experiment was undertaken with use of the two-dimensional γ-ray heating calculation code, 2D-GAMM, which was developed by taking account of γ-ray transport. The results of the analysis of the mock-up experiment of JOYO FBR in V3-B1 and V3-B4 assemblies have revealed that although the experimental values and the calculated values of the γ-ray exposure dose distributions agree very well with each other in the core, these values in the blanket are systematically under-estimated. By correcting the γ-ray source distribution with the measured values of the reaction rate distribution of ^{235}U and ^{239}Pu at the blanket and the values obtained by the two-dimension diffusion calculation, the calculated values and the experimental values in the blanket will be in good agreement. Also, the calculated values in the sodium channel have been found to be over-estimated. (auth)

17428 (JAPFNR-106) VIBRATION TEST FOR GRAPHITE SHIELDING STRUCTURE. (Ministry of Construction, Tokyo (Japan). Building Research Inst.). Mar 1972. 144p. (PNC-J-290-72-1). Dep. NTIS (U.S. Sales Only) $9.25.

The results of tests performed to examine the seismic resistant stability of graphite shielding and its supporting structures in fast breeder reactors are presented. (auth)

17429 (JAPFNR-112) PRESENT STATUS OF THE RESEARCH AND DEVELOPMENT OF THE FBR FUELS AND MATERIALS. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1973. 4p. (PNC-N-241-73-27 (5)). Dep. NTIS (U.S. Sales Only) $3.00.

Research progress in the development of fuels, cladding materials, absorbers, and structural materials for FBR type reactors is briefly summarized. (JWR)

17430 (JAPFNR-113) CREEP TESTS ON JOYO FUEL CLADDING TUBES OF SECOND TRIAL FABRICATION. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1973. 24p. (PNC-N-241-73-27(6)). Dep. NTIS (U. S. Sales Only) $3.25.

The results of creep and creep rupture tests on stainless steel-316 tubes representing the second trial fabrication of fuel cladding tubes for the Joyo Reactor are presented. (JWR)

17431 (KFK-EXT-25/72-1) FINAL REPORT ON WORK COMPLETED BY GfK DURING PHASE IIa OF THE FAST BREEDER PROJECT. Engelmann, P.; Hueper, R.; Karsten, G.; Kessler, G.; Schroeder, R.; Stamm, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb 1973. 61p. (In German). Dep. NTIS (U. S. Sales Only) $5.25.

The research and development work in support of the design of a 300 MW(e) fast breeder prototype (SNR 300) is described. Accomplishments in the following fields are reported: fuel rod development (study of materials; successful irradiation tests in fast neutron flux); fuel cycle (reprocessing and fabrication studies); physics (critical experiments in SNEAK; subprompt and superprompt critical tests in SEFOR; code development concerning nuclear data evaluation and reactor theory); reactor design (thermo- and fluid-dynamic studies of components); sodium technology (measurements of fretting, wear, corrosion); and safety and protective instrumentation (core dynamics codes; sodium boiling tests; can failure detection devices). A detailed list of reports giving results of the various studies is included. (auth)

17432 (ORNL-4832) MOLTEN-SALT REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 31, 1972. (Oak Ridge National Lab., Tenn.). Mar 1973. Contract W-7405-eng-26. 204p. Dep. NTIS $12.25.

Information on the MSBR is presented concerning design and development; chemistry; materials development; and fuel processing for molten-salt reactors. Separate abstracts are included for each of the 4 sections presented. (DCC)

For abstracts of individual sections see: 15267, 15413, 15938, and 17433.

17433 (ORNL-4832, pp 1-36) PART 1. MSBR DESIGN AND DEVELOPMENT. Briggs, R. B.; Haubenreich, P. N. Mar 1973. Molten-Salt Reactor Program Semiannual Progress Report for Period Ending August 31, 1972.

Information on the MSBR design and development program is presented concerning design parameters for lead-cooled MSBR; design parameters for 1000 MW(e) NaK-cooled MSBR; ^{135}Xe distribution in MSBR fuel salt system; physics calculations for lead-cooled MSBRs; plutonium use in MSBR; gaseous fission product removal; steam generators; coolant salt pumps; heat transfer in MSBR fuel salt; and thermal conductivity of MSBR fuel salt. (DCC)

17434 (RT/FI-(73)2) SHIELDING PROBLEMS IN THE PEC REACTOR. Canali, U.; Cicognani, G.; Corbo, N.; Farnelli, U.; Nicks, R.; Penkuhn, A.; Ponti, C.; Tavoni, R.; Tondinelli, L.; Travaglini, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Jan 1973. 18p. (CONF-721018-25; RVI-PEC-672). Dep. NTIS (U.S. Sales Only) $3.00.

From 4th international conference on reactor shielding; Paris, France (9 Oct 1972).

The PEC reactor is a sodium cooled fast reactor designed mainly for testing fast reactor fuel elements. Its peculiar geometry, also due to the presence of the test zone, originates some particular shielding problems besides those typical of sodium cooled fast reactors. The problems encountered in the design of the shields of the reactor, the extensive set of calculations that have been performed, and the critical points that have been identified are reported. (auth)

17435 (WARD-RB-3045-1) RADIAL BLANKET DESIGN AND DEVELOPMENT. Quarterly Progress Report for Period Ending February 28, 1973. Bishop, E. C. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). May 1973. Contract AT(11-1)-3045. 49p. AT $5.45.

Progress in the design and development of LMFBR radial blankets for the period is reported. The research included heat transfer tests and EBR-II irradiation tests. (JWR)

17436 (WARD-SS-3045-1) RADIAL BLANKET AND SHIELD SIMULATION EXPERIMENTS. Quarterly Progress Report for Period Ending April 30, 1973. Rittenberger, R. V. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1973. Contract AT(11-1)-3045. 48p. AT $4.00.

Progress in research on shielding requirements for LMFBR's is reported. Work during the period consisted of post-experimental analyses of the radial blanket simulation experiments. (JWR)

17437 SOURCES OF ERRORS IN THE THERMAL SIMULATION OF FUEL RODS BY HEATING RODS AND THE DETERMINATION OF LOCAL CLADDING TEMPERATURES. Malang, S.; Moeller, R.; Rust, K.; Tschoeke, H. (Kernforschungszentrum, Karlsruhe, Ger.). (1973). vp. (In German).

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

The differences in temperature and heat flow between the fuel rod and examined heating rods are systematic derivations whose values can be calculated. In addition, two further types of errors are investigated: errors due to tolerated inaccuracies in the fabrication of the heaters and errors in the determination of the local cladding temperature by measurements. The total error to be expected from these investigations of temperature variation at the rod circumference is less than 4°C for the critical rod next to the wall of a SNR 300 fuel element. It is possible to achieve a sufficient degree of accuracy with such instrumented heaters. (GE)

17438 NUCLEAR UNCERTAINTIES OF SNR-300 AND THEIR CONSEQUENCES FOR CORE DESIGN. Wehmann, U. (Internationale Atomreaktorbau GmbH, Bensberg, Ger.); Pilate, S.; Wintzer, D. (1973). vp. (In German).

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

The experimentally studied quantities in SNEAK, such as critical mass, power distribution, absorber efficiencies, and Na-void effect, have been computed. This evaluation allowed a detailed test of cross sections, calculation methods, and models which are used in the design of the SNR-300. Uncertainties in the prediction of neutron physics parameters of the SNR 300 (1.7 delta) 1972 and their expected improvements are compiled in tabular form as well as the contributions of critical mass of the fresh core. (GE)

17439 FUEL ELEMENT FOR A REACTOR. Mueller, A. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,589,842. 5 Mar 1970. Filed date 23 Aug 1967. 17p. (In German).

Fuel elements are described for a nuclear reactor, especially for a fast steam-cooled breeder reactor, with a number of vertically elongated individual fuel elements bound together in a fuel bundle. The fuel elements are provided with cooling fins serving simultaneously as a spacing container. The fins in the form of individual broken or closed rings are arranged at stated intervals on the sides of the single fuel elements. The cross section area, limited by the rings, intersects the longitudinal axis of the single elements in an oblique angle. The circular cylindrical single elements are characterized by ellipsoid rings as cooling fins whose small axis corresponds to the diameter of the single elements. (JSR)

17440 INSTALLATION FOR SURVEYING THE DISPLACEMENT OF A STRUCTURE IN A NUCLEAR REACTOR. Debergh, P.; Lagrange, M. (to Commissariat a l'Energie Atomique). U. S. Patent 3,737,372. 5 Jun 1973. Priority date 10 Apr 1970, France. 4p.

The installation comprises a closed tube, one end of which contains a sighting gage and which is supported by the structure to be surveyed while the other end of the tube, which is closed by a viewing window, is centered and maintained elastically within an opening of a stationary component. An observation tube is fixed in the opening of the stationary component and connects an object lens placed directly above the viewing window to an optical system. (Official Gazette)

17441 STRUCTURAL MATERIALS ASPECTS OF LMFBR CORE-RESTRAINT SYSTEM DESIGN. Pennell, W. E. (Westinghouse Electric Corp., Madison, PA). Nucl. Technol.; 16: No. 1, 332-353(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

Core-restraint-system design experience has shown the irradiation creep and swelling design equations to be valuable design tools. The principal difficulty encountered in using these equations occurs when the two effects must be superposed, particularly when creep is used to offset the effects of swelling. The difficulty arises due to the wide range of results obtainable within the swelling-creep confidence limit envelope. An improved understanding of swelling–creep superposition behavior would be of considerable benefit to the core-restraint-system

designer. The slit-tube test offers a near-term means of obtaining some swelling-creep superposition data. (18 figures, 13 references) (auth)

17442 SPACING DEVICES FOR A TUBULAR ARRAY: HEAT EXCHANGE UTILIZING THESE DEVICES. Nguyen-Thanh. (to Stein Industrie). French Patent 2,128,197. 20 Oct 1972. Filed date 11 Mar 1971. 10p. (In French).

Spacing devices for positioning the tubes of a tubular array of a heat exchanger are described. These devices are particularly intended for the liquid sodium–water heat exchangers of the vapor generators of power plants with fast neutron reactor plants. These devices consist of sheet steel spacer assemblies, which are assembled during the construction of the exchanger. In this way the welds can be inspected as the construction proceeds. The operational safety is also improved. (FR)

17443 INSTALLATION FOR MEASURING THE NEUTRON FLUX OF A LIQUID COOLED NUCLEAR REACTOR. Culambourg, J.; Marmonier, P.; Naudet, R.; Sauvage, M. (to Commissariat a l'Energie Atomique). French Patent 2,126,921. 13 Oct 1972. Filed date 20 Jan 1971. 9p. (In French).

An installation for measuring the neutron flux for liquid cooled reactors (principally fast neutron sodium cooled reactors) is presented. It consists of a neutron detection chamber positioned beneath the vessel containing the liquid coolant and the core (consisting of juxtapositioned vertically insertable fuel assemblies). The installation is also provided with a tubular enclosure filled with an inert gas which extends from the core up to the inner wall of the vessel. (FR)

17444 MANIPULATION INSTALLATION FOR NUCLEAR REACTORS. Ventre, E. (to Electricite de France). French Patent 2,126,918. 13 Oct 1972. Filed date 15 Jan 1971. 11p. (In French).

A manipulation installation for nuclear reactors is presented. A rotating platform supporting several reactor cores is positioned inside the vessel containing the liquid metal coolant. The rotating platform serves to displace the cores from their operating positions to their recharging positions. The installation includes a tubular manipulation recipient which is open at its lower end and suspended in an orifice provided in the upper slab of the reactor vessel sealing device, this part supporting an internal annular gallery for intermediate storage. A first manipulation arm is provided for transferring fuel assemblies between the core and the storage gallery. A second manipulating arm transfers the fuel assemblies between the gallery and the well communicating with the outside. (FR)

17445 HEAT TRANSFER TESTS ON INTERMEDIATE HEAT EXCHANGER MODEL FOR LMFBR. Abe, Y.; Maita, M.; Fujimoto, T.; Ueda, S.; Tamaki, M. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho; 10: No. 2, 175-183(Mar 1973). (In Japanese).

Two sodium test loops were constructed in Kobe Technical Institute. One is the Shinmei Sodium Loop (KL-1) which has been used to develop components. The other is the Mass Transfer Test Loop (KL-2) for mass transfer study. The details of KK-1 Loop are presented. Experimental tests on heat transfer in the IHX of the Shinmei Sodium Loop were performed. The design of the IHX is cross flow type with semi-circular baffles and floating head. Test results indicated that the application of the Lubarsky–Kaufman's equation to the tube side heat transfer and the modified Donohue's equation to the shell side heat transfer was satisfactory at design conditions. However, it was found that the application of the above two equations gave higher heat transfer rate at lower Reynolds numbers or Peclet numbers. (auth)

17446 ATOMIC POWER GENERATION AND OIL PRESSURE. Seki, N. (Mitsubishi Atomic Power Industries, Inc., Tokyo). Yuatsu Gijutsu; 11: No. 4, 78-81(Apr 1972). (In Japanese).

The employment of oil pressure in atomic power plants is discussed in connection with the development of sodium cooled fast breeder reactors. Reasons why oil pressure is not used for water reactors are explained. The applications of oil pressure for the power to operate reactor shielding plugs is explained with the example of an experimental fast breeder reactor, JOYO, now under construction in Japan. Application for piping snubbers is also explained. Radiation damage of organic materials is discussed. Radiation dosage for various kinds of rubber, plastic material and oil are summarized in three tables. The maximum permissible intensity of radiation to secure 30 years consecutive use of oil pressure machinery is estimated to be 3.3m rem/sec/cm^2. (JA)

17447 COOLANT MIXING IN A FUEL PIN ASSEMBLY UTILIZING HELICAL WIRE WRAP SPACERS. Collingham, R. E.; Thorne, W. L.; McCormack, J. D. (Westinghouse Hanford Co., Richland, WA). Nucl. Eng. Des.; 24: No. 3, 393-409(1973).

Coolant mixing in a helically wire-wrapped, 217 pin, full-scale model of an LMFBR fuel assembly is presented. Salt-injection–conductivity techniques were employed, using water as the coolant. Over four hundred probes were concentrated in a one-sixth sector of the assembly to exhaustively measure the salt distribution. The basic results are presented for use in the verification of thermal hydraulic computer codes and wire-wrap mixing models. Interior channel gross mixing rates were about 9%/cm (effectively 3% per cm per gap); this was more than three times the natural turbulence level. There existed only a small peripheral (swirl) flow around the bundle; its direction averaged only slightly greater than half helical wire wrap angle. The results were reduced into an effective turbulent mixing model, and a wire-wrap forced diversion cross flow model is also presented. (auth)

17448 EMERGENCY SHUT-DOWN COOLING OF THE BOR-60 REACTOR. Kazachkovskii, O. D.; Antipin, G. K.; Afanas'ev, V. A.; Bai, V. F.; Borisyuk, V. A.; Borisyuk, E. V.; Gryazev, V. M.; Efimov, V. N.; Kevrolev, V. P.; Kondrat'ev, V. I.; Krasnoyarov, N. V.; Smirnov, A. M. At. Energ. (USSR); 34: No. 5, 341-344(May 1973). (In Russian).

To decrease thermal stress in structural components of the reactor installation the possibility is examined of circulating pump shut-down and using the inertia of flux and rotating parts to remove afterheat as the power decreases when the safety system is actuated during transition to natural circulation conditions. It has been established that after actuation of the safety system reactor temperature conditions differ little from those prevailing during the preceding steady state. The subassembly outlet temperature did not exceed the permissible value. Based on the results obtained safe and simple diagrams were prepared for emergency shut-down and cooling of the BOR-60 reactor. (auth)

17449 FLOW AND VIBRATION MEASUREMENTS WITH A FAST BREEDER FUEL ELEMENT IN SODIUM. Voj, P.; Hess, B.; Ruppert, E. (INTERATOM, Bensberg, Ger.). Atomkernenergie; 21: No. 1, 9-16(1973). (In German).

A complete, instrumented SNR-300 fuel element has been investigated in the AKB sodium loop. In addition to long-term tests of the fuel element during a period of 1,200 hours at near-reactor conditions, comprehensive sodium instrumentation was tested and information on the hydraulic and vibrational behavior of the fuel element was obtained. Mass flow through the element was varied between 0 and 14% of the nominal value for isothermal measurements at temperatures ranging from 300°C to 600°C. Measurements of pressure loss across characteristic sections of the element were in good agreement with the results of comparable water tests. Leakage at the hydraulic hold down was <0.7% of the mass flow through the fuel element. Lateral distribution of relative velocity was measured by means of special miniature flow meters inside several of the fuel pins. Distribution was found to be symmetrical and no disturbances due to inlet geometry were detected. Flow-induced pin vibrations have been measured using miniature strain gauges spot-welded to the inside of certain fuel cans. The vibrations measured exhibit a broad distribution with a clear maximum at 250 Hz and the strains measured within 3 sigma probability limits at 140% nominal flow, fall well below Woehler's curve. Similar vibration measurements on the fuel element wrapper indicate a frequency of 20 Hz and 300 μD circumferential bending strain at nominal flow which is consistent with theoretical estimations. (GE)

17450 REACTOR TANK OF THE SNR-300. Koehler, M.; Rothfuss, H. (Interatom, Bensberg, Ger.). Kerntechnik; 15: No. 2, 75-79(1973). (In German and English).

The SNR 300 is designed on the loop concept. The reactor tank, together with its internals and its cover forms an independent construction unit. The design of the individual structural components is governed by safety stipulations of which the most important are the measures for maintaining core cooling in the event of total pipe fracture and total failure of the main heat transfer systems, the measures for controlling the consequences of hypothetical accidents with release of mechanical energy, and the arrangements adopted for reliably securing the core elements in position. (GE)

17451 SECONDARY VAPOR SUPERHEATING WITH VAPOR-COOLED REACTORS. Spennemann, L. German Patent 1,576,874. 18 Jun 1970. Filed date 28 Sep 1967. 13p. (In German).

A method is described for secondary vapor superheating in vapor-cooled reactors, especially vapor-cooled fast reactors. The evaporation of the liquid coolant occurring under pressure from reactor-heated vapor takes place in heat exchangers. The vapor, after a part of its energy is given up, is superheated again in another zone of the reactor. (JSR)

17452 DEVELOPMENT OF STEAM GENERATOR FOR LIQUID METAL FAST BREEDER REACTOR. Kawahara, S. (Hitachi

Ltd., Ibaraki, Japan); Sugiyama, S.; Komeno, A.; Kawara, M. Hitachi Hyoron; 55: No. 3, 213-218(Mar 1973). (In Japanese).

Many research and development programs associated with the Liquid-Metal Fast Breeder Reactor (LMFBR) have been conducted by the Power Reactor and Nuclear Fuel Development Corporation (PNC) in Japan. The steam generator is a key component in an LMFBR plant and it has many problems to be solved in engineering and design. Hitachi, Ltd. has done research and development programs on steam generators taking part in the PNC steam generator projects. A 1 MW steam generator for the PNC was designed and fabricated by Hitachi, Ltd. and was installed at Oarai Engineering Center of the PNC in August, 1971. Since then, steady state and transient operation tests have been conducted. The valuable data obtained have since been under analysis at the PNC. Features of sodium-heated steam generator, development programs at Hitachi, Ltd. and the design, fabrication and operation of the 1 MW steam generator for the PNC are described. (auth)

17453 VENTING DEVICE FOR SODIUM-COOLED FAST REACTOR CERAMIC FUEL ELEMENTS. Martini, M.; Gerosa, A. (CEN, Rome). Nucl. Technol.; 19: No. 2, 96-110(Aug 1973).

Out-of-reactor feasibility studies of hydrostatic-type venting devices for individual fast reactor fuel pins have been made. The following features were common to all of the devices tested: absence of moving parts; independence of capillarity effects; compactness; small effect on coolant pressure drop; standard materials and techniques of fabrication; and inherent safety. The tests, run between June 1968 and May 1969, verified that the preferred double capillary tube venting device, named DISCA, operated as designed under both steady-state and transient conditions. In-reactor tests of this and other venting devices are in progress. (auth)

Research, Test, and Experimental Reactors

Refer also to abstracts 15235, 15607, 15625, 17377, 17421, 17422, and 17634.

17454 (AD-754452) FUCHS MODEL FOR THE DASA-TRIGA REACTOR. Carmpton, T. (Armed Forces Radiobiology Research Inst., Bethesda, MD). 30 Apr 1963. 21p. NTIS.

During the Phase I training of AFRRI reactor operators, a solution of the so-called Fuchs Model for pulsing reactors was presented. A much simplified derivation for the closed form of the power function was found. The greatest simplification arose from the somewhat unnatural postponement of the evaluation of an integration constant. Excepting this one artificiality, the solution becomes an elementary and straightforward calculus exercise. An exact expression for the peak power in terms of natural parameters and reactor constants was found. Very sharp estimates of certain constants are given in terms of initial and peak power. (auth)

17455 (AECL-4506) REACTOR PHYSICS MEASUREMENTS USING PLUTONIUM ENRICHED-UO_2 FUEL IN ZED-2. Part I. Results of Experiments. Kay, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1973. 79p. Dep. NTIS (U. S. Sales Only) $6.00. AECL $2.00.

Experiments have been performed in ZED-2 using 2 wt % PuO_2-UO_2 fuel elements arranged into either a single 19-element booster rod or four 16-element booster rods. These boosters were inserted into a reference lattice containing 28-element UO_2 fuel assemblies. Measurements were made of the perturbing effect of the boosters on the surrounding lattice, neutron density and spectrum parameters within a booster, and reactivity effects. Similar measurements were made when H_2O, copper and cadmium absorbers were inserted at the center of a lattice in which the four central lattice positions were occupied by booster rods. (auth)

17456 (AEEW-R-844) DESIGN AND MANUFACTURE OF SODIUM FILLED CALANDRIA FOR USE IN ZERO POWER FAST REACTORS. Hilton, R. K.; Jamieson, G. R.; Mason, P.; Waltham, I. (Atomic Energy Establishment, Winfrith (England)). Dec 1972. 26p. Dep. NTIS (U.S. Sales Only) $3.50.

Three types of stainless steel calandria, their method of manufacture, including the adaptable semi-automatic welding machines which were designed for their fabrication, and the techniques and equipment for filling the calandria with sodium are described. (auth)

17457 (ANCR-1101) TEST AND ANALYSIS OF TRA SEISMIC SCRAM SWITCHES. Gold, S. J. (Idaho Nuclear Corp., Idaho Falls). Jul 1968. Contract AT(10-1)-1230. 28p. Dep. NTIS $3.50.

The seismic scram switches used at TRA have been tested by subjecting them to simulated earthquake shocks. These switches are critically damped pendulums having a period of one second. During the tests, the switches generated a scram signal within the first half cycle of acceleration at 2.5 Hz and a < 0.01 g. Therefore, the reactors at TRA would be scrammed near the beginning of any earthquake with a Modified Mercalli Intensity greater than 4.0, which is a level of no damage. (auth)

17458 (BNL-17901) EXPERIENCE WITH STRESS CORROSION CRACKING AND MATERIALS COMPATIBILITY AT THE HIGH FLUX BEAM REACTOR. Powell, R. W.; Chow, J. G. Y.; Brynda, W. J.; Brooks, M. H.; Weeks, J. R. (Brookhaven National Lab., Upton, N. Y.). 1973. 16p. (CONF-730801-4). Dep. NTIS $3.00.

From symposium on materials performance in operating nuclear systems; Ames, Iowa, USA (28 Aug 1973).

The primary system components of the High Flux Beam Reactor are fabricated from two types of metals, aluminum 6061 and stainless steel Type 304. The aluminum reactor vessel and fuel element cladding establish the basis for the primary coolant system water and cover gas chemistry. An 18 in. dia stainless steel weld-neck flange, which was a component of the primary coolant system piping, failed due to intergranular stress corrosion cracking. Stress analyses showed that hoop stresses due to high bolt tension were sufficient, when coupled with other circumstances, to be of significance. Detailed metallurgical analyses of some of the cracked pipe sections identified the cracks as intergranular cracks which originated from the inside surface. The cracks seemed to originate in the heat affected zone but none extended into the weld material. The replacement flange, of the stub end type, was not subject to hoop stresses shown to have existed in the weld neck type. (auth)

17459 (CONF-721012-3) USING EXISTING DATA FOR COMPONENT DESIGN CONSIDERING CREEP-FATIGUE INTERACTION. Snow, A. L. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). 1972. Contract AT(45-1)-2171. 45p. Dep. NTIS $4.25.

From fall meeting of the society of experimental stress analysis; Seattle, Washington, USA (17 Oct 1972).

The Fast Flux Test Facility is first reactor system designed per the rules of Code Case 1331-5 of the ASME Code. The 1050°F design temperature places the 304 and 316 austenitic stainless steel components into the creep domain. Applications of structural analysis, including creep and plasticity effects, are presented. Problems and future needs are discussed. (auth)

17460 (JAERI-M-5025) REPORT ON THE OPERATION, UTILIZATION, AND TECHNICAL DEVELOPMENT OF RESEARCH REACTORS AND HOT LABORATORY. (Japan Atomic Energy Research Inst., Tokyo). Nov 1972. 183p. (In Japanese). NTIS (U. S. Sales Only).

The Division of Research Reactor Operation is engaged in the operation, maintenance, etc. of JRR-2, JRR-3 and JRR-4 (Japan Research Reactors), and of the Hot Laboratory for post-irradiation tests of reactor fuels and materials. In the division, besides the operation and maintenance, other work is also performed, including the control of water and gas, radiation control, and irradiation. Further, research and development work on the technology of research reactors and facilities is performed. Research is in progress on the deposition of fission products with a TLG-1 gas loop. In the Hot Laboratory, works performed include tests in monitoring of fuel and materials of the JAPCO's power reactor and post-irradiation tests of various fuels being developed. The activities in fiscal 1971 (April to March) in the division and problems encountered and the procedures applied to solve them are described. (auth)

17461 (ORNL-TM-4014) ONE-DIMENSIONAL CALCULATIONS IN SUPPORT OF THE REACTIVITY SURVEILLANCE PROCEDURES FOR THE FAST TEST REACTOR. Flanagan, G. F.; Simpson, D. B.; Buhl, A. R. (Oak Ridge National Lab., Tenn.). Apr 1973. Contract W-7405-eng-26. 81p. AT.

The one-dimensional reactor physics models and cross-section evaluations as they pertain to the Reactivity Surveillance Procedures (RSP) Program of the Fast Flux Test Facility are summarized. Included also is a description of the techniques used to generate multigroup transport-diffusion cross sections for use in future fast reactor calculations. A study was made to examine the adequacy of using diffusion theory approximations for calculating reactor fluxes which are used in estimating neutron detector efficiencies. Results indicate that in one-dimension, the combined S_2 "diffusion" option in ANISN along with a P_1 expansion of the cross section gives fluxes and reaction rates which are comparable to those calculated using S_8P_3 transport theory. However, different cross-section sets used in the same model

gave widely varying results thus indicating the need for judicious selection of cross-section sets for use in the RSP Programs. (auth)

17462 (ORNL-TM-4270) BULK SHIELDING FACILITY QUARTERLY REPORT, JANUARY–MARCH 1973. Tabor, W. H.; Hurt, S. S. III; Lance, E. D. (Oak Ridge National Lab., Tenn.). Jun 1973. Contract W-7405-eng-26. 29p. Dep. NTIS $3.50.

The BSR operated at an average power level of 1477 kW for 26.5% of the time during January, February, and March. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 52.750 hours to provide training for nuclear engineering students from the University of Oklahoma and Mississippi State University. The PCA was operated 11 days during this quarter. Nuclear engineering students from the University of Tennessee, University of Oklahoma, University of Kentucky, and Mississippi State University participated in training labs during this time. (auth)

17463 (SURRC-48/73) ANNUAL REPORT, 1971–72. Wilson, H. W. (Scottish Research Reactor Centre, East Kilbride (Scotland)). 1972. 32p. Dep. NTIS (U.S. Sales Only) $3.75.

Activities at the Scottish Universities Research and Reactor Centre during the 1971–72 session are briefly summarized. The research included neutron radiography, fission physics, atomic excitation in alpha decay, reactor physics, heat transfer, nuclear engineering, radiochemistry, activation analysis, isotope production, health physics and nuclear medicine, and isotope geology. (JWR)

17464 (WARD-2171-33) FAST FLUX TEST FACILITY. Quarterly Progress Report, September–November 1972. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Apr 1973. Contract AT(45-1)-2171. 118p. AT $5.45.

Research and development activities for the FFTF Reactor are presented under the following headings: reactor system design and engineering; reactor analysis; reactor core system; fuel assemblies; reactor enclosure system; core support structure; control rod system; startup system; closed loop in-reactor assembly; in-vessel handling machine; reactor plant system engineering; plant control and data acquisition; component test and materials analysis; and project administration. (DCC)

17465 (WARD-5941) FFTF PROBE TYPE EDDY-CURRENT FLOWMETER WET VS. DRY PERFORMANCE EVALUATION IN SODIUM. Costello, T. J.; Laubham, R. L.; Miller, W. R.; Smith, C. R. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). 1972. Contract AT(45-1)-2171. 14p. (CONF-721109-24). Dep. NTIS $3.00.

From international conference on nuclear solutions to world energy problems; Washington, District of Columbia, USA (12 Nov 1972).

An eddy-current flowmeter (ECFM), designed to measure the velocity of coolant sodium exiting the fuel subassemblies of the Fast Flux Test Facility (FFTF), was tested in the Westinghouse Advanced Reactors Division's General Purpose Loop No. 2 (GPL-2) during the period of October 2, 1971 to March 16, 1972. The ECFM was operated in both a wet and dry prototypic (FFTF) design test housing. In the wet design test housing, the ECFM is exposed directly to sodium; in the dry design test housing, the ECFM is shielded from sodium by a stainless steel "thimble." During both tests, the same ECFM electronics supply and associated wiring was used. The same ECFM electrical adjustments also were employed in both cases. Throughout the total testing period of 1351.6 hours, the ECFM operated satisfactorily. No failures or malfunctions occurred in the ECFM, its power supply, or the three test thermocouples. Significantly, the data showed that the ECFM's overall average dc output signal in the dry design was 62% of that in the wet design. (auth)

17466 (WARD-NA-3045-1) SODIUM TECHNOLOGY PROGRAM. Progress Report for Period Ending April 30, 1973. Ray, W. E. (Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). Jul 1973. Contract AT(11-1)-3045. 103p. AT.

Wear testing of FFTF fuel assembly duct load pad is described. The different frictional characteristics of the various coatings are identified. Samples of Stellite 6 on Stellite 6 and Inconel 718 on Inconel 718 are tested with contact loads in flowing sodium at 1050°F to determine the self-welding tendencies of the FFTF primary loop isolation valve components. The decarburization of FFTF fuel cladding materials is reviewed. Materials studied include: Type 304 stainless steel, Type 316 stainless steel, Type 321 stainless steel, and Incoloy 800. The liquid sodium test loops for the decarburization experiments are described. The sodium compatibility of FFTF fuel assembly duct load pad chromium carbide coating materials is studied. The effects of 1000°F and 1200°F liquid sodium on Type 30A stainless steel are studied. (DCC)

17467 (ZJE-137) INTERCOMPARISON OF REACTOR CALORIMETERS. Proceedings of the International Seminar, Swierk, Poland, May 15–27, 1972. (Institute of Nuclear Research, Swierk (Poland); Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1973. 146p. Dep. NTIS (U.S. Sales Only) $9.50.

The results of calorimetric measurements on the EWA-10 Reactor are presented. The results were used to compare the properties of the various calorimeters tested. (JWR)

17468 COMPARISON BETWEEN PREDICTED AND MEASURED TEMPERATURE COEFFICIENTS OF REACTIVITY IN SOME LIGHT WATER LATTICES. Andersson, G.; Edenius, M.; Hellstrand, E.; Persson, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). (1973). vp.

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

A description is given of investigations in the high temperature facility KRITZ at Studsvik. Comparison between the measured and calculated values indicates that the difference in temperature dependence of reactivity should not be emphasized. (GE)

17469 METHOD FOR THE PRODUCTION OF A NEUTRON IMPULSE FLASH AND A NUCLEAR REACTOR FOR ITS REALIZATION. Gassiev, I. A.; Kiknadze, G. I.; Garsevanishvili, G. N.; Akhobadze, V. N. (to Institut Fiziki Akademii Nauk Gruzinskoi SSR). British Patent 1,303,977. 24 Jan 1973. Filed date 18 Feb 1971. 4p.

A method and apparatus are described for the production of neutron impulse flashes. Disadvantages of previous methods are stated. The entire mass of nuclear fuel is shot through a neutron moderator containing no nuclear fuel and the fuel is removed from the moderator vessel as soon as the flash is produced. It is preferable that the fuel be cooled after each neutron impulse flash so that it can be utilized repeatedly. (UK)

17470 PROCEDURE FOR CAUSING AN IRRADIATION RABBIT TO ROTATE IN A PNEUMATIC TUBE AND THE CORRESPONDING APPARATUS. Junod, E.; Laverlochere, J. (to Commissariat a l'Energie Atomique). French Patent 2,074,702. 8 Oct 1971. Filed date 20 Oct 1970. (In French).

The procedure for starting an irradiation rabbit to rotate in a vertical portion of a pneumatic tube in the vicinity of a reactor core is described. The procedure consists of maintaining the rabbit at a fixed height in the tube and causing it to turn about a vertical axis by blowing compressed air against the fins of the rabbit. (TSS)

17471 PROJECT KNK-II. Andrae, H. (Interatom, Bensberg, Ger.); Marth, W. Atomwirt., Atomtech.; 18: No. 2, 93-95(1973). (In German).

The project KNK-II involves the conversion of the KNK-I plant with thermal core into a fast core. The project aims of the KNK-II plant are defined by the experimental results on the irradiation of fuel rod bundles, each containing about 1,500 rods, which are required for the SNR-300. This irradiation has to take place under operating conditions which approximate to those in SNR-300. Further aims of the KNK-II plant include the testing of in-core instrumentation as well as the acquisition of commissioning and operating experience with a fast core. The building license for KNK-II is expected in the autumn of 1973. Start of the power operation of the plant may be expected at the end of 1974. (GE)

17472 SIGNIFICANCE OF THE COMPACT SODIUM-COOLED NUCLEAR REACTOR PLANT (KNK). The First Step Towards the Realization of the SNR 300 Project. Armbruster, H. (Kernkraftwerk-Betriebsgesellschaft mbH, Leopoldshafen, Ger.); Eitz, A. W.; Harde, R. Atomwirt., Atomtech.; 18: No. 2, 84-85(1973). (In German).

The KNK reactor was developed as the prototype of a compact sodium-cooled thermal power reactor. When the decision for construction was made it was certain that KNK would represent an essential first step in the development of sodium-cooled fast reactors. The plant was offered on a fixed-price turn-key basis and was erected on time within the allotted costs. The experience gained in the field of sodium technology has been of great importance. The nuclear commissioning has contributed to further technical and safety-technical know-how. During the licensing process the KNK plant was dealt with in terms of its significance as a prototype of sodium-cooled reactors. In 1968, during its construction, the project KNK-II materialized where the plant will be equipped and operated with a fast core containing plutonium. KNK-II will represent a valuable test bed for the development of fuel

elements for SNR-300. The plant is comprehensively instrumented and offers the possibility of testing various additional nuclear instrumentation before it is introduced into the SNR. The conversion to KNK-II is scheduled for the end of 1973 and will take about nine months. (GE)

17473 CONSTRUCTION AND COMMISSIONING EXPERIENCE WITH KNK. Gilles, J. (INTERATOM, Leopoldshafen, Ger.); Hendl, G.; Herberg, G.; Mausbeck, G.; Brudermueller, G.; Finke, G. Atomwirt., Atomtech.; 18: No. 2, 88-93(1973). (In German).

The commissioning phase was separated into four stages: commissioning and testing of individual systems without sodium, testing of technical procedures under sodium conditions, fuel element loading and zero power test, and nuclear power operation. The testing of the main components of the heat transfer system proceeded with essentially no problems. A leak with a subsequent sodium–water reaction occurred in one of the steam generators during the power testing. The commissioning of the electrical heating and the electrical start-up heating encountered difficulties. The nuclear testing comprised the critical experiment and the assembly of the target core, the sodium run-off experiment, measurements for the determination of the reactivity coefficient at zero power, calibration of the control rod, testing of the natural circulation behavior, and the behavior after rapid shut-down and power operation. The delays during commissioning are attributable to advance knowledge during construction and commissioning, to the lack of conventional components and to insufficient experimental experience. (GE)

17474 EXPERIENCE GAINED FROM THE PROJECT KNK. Brudermueller, G. (Kernkraftwerk Betriebsgesellschaft mbH, Leopoldshafen, Ger.); Marth, W.; Tebbert, H. Atomwirt., Atomtech.; 18: No. 2, 85-87(1973). (In German).

The experience gained by the owner and operator during the building and commissioning of KNK-I and KNK-II is primarily due to six years of daily routine work, also to the working of the chosen organizational model used for carrying out the project. The projects KNK-1, KNK-II and SNR-300 are linked together. The controlling factor in the development of the KNK project is that KNK-II should have an operational lead of at least three to four years over SNR-300 in order that it can provide sufficient operating experience. It was possible to finish the building and assembly on time even though a delay of two years occurred at the commissioning stage. Troubles which led to this delay are described. (GE)

17475 REACTOR SAFETY AND NSRR PROGRAM. At. Jap.; 16: No. 7, 18-20(Jul 1972).

The Japan Atomic Energy Research Institute (JAERI) has a three-year program with plans to build a new experimental facility named NSRR (Nuclear Safety Research Reactor) in the Tokai establishment with the total investment of 2,500 million yen. The facility will be used for research that will contribute to the safer and more efficient use of reactors and nuclear fuel. Research on nuclear reactor safety is divided roughly into thermo-mechanical and nuclear research, according to the division of reactor accidents into two major categories, mechanical and nuclear. Of the accidents in the first category, the most serious is loss-of-coolant through the breakdown of the primary system. The accidents in the second category occur when the output power of the reactor rises unusually fast. The most important subject of the safety research concerns ways in which leakage of fission products from the fuel can be prevented. For this purpose, all reactors have three types of shields, fuel cladding, pressure vessels, and containers. The NSRR program deals with the first shield, that is, the fuel cladding and the reactor core. In the NSRR program, JAERI uses a TRIGA-ACPR purchased from GGA of the United States. Following the experiment with water capsules, the effect of the conditions of the coolant on destruction will be studied using a water loop in the pattern of water-cooled reactors and fast breeder reactors. Later, experiments with spent fuel will begin in order to study the aging of cladding materials and the destruction effect caused by the accumulation of fission products. (JA)

Production and Materials Testing and Processing Reactors

Refer also to abstracts 17457, 17521, and 17548.

17476 (DP-1329) CONFINEMENT OF AIRBORNE RADIOACTIVITY. Progress Report, July–December 1972. Evans, A. G. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab). Jun 1973. Contract AT(07-2)-1. 18p. Dep. NTIS $4.00.

Radiolytic desorption tests of new and used carbons show that TEDA-impregnated carbons retain iodine better after 6 months service in the confinement system than does new unimpregnated carbon. Iodine retention properties of a 2% TEDA-2% KI carbon are as good as a 5% TEDA carbon. The ignition temperature of the carbon decreases with TEDA impregnation and carbon heating rate. A 5% TEDA carbon ignites at temperatures above 190°C at a face velocity of 55 ft/min. A 2% TEDA carbon may be satisfactory for use up to 290°C, depending on the heating rate and heat transfer rate of the system. (11 references) (auth)

17477 HIGH-TEMPERATURE REACTOR IN THE IRON AND STEEL INDUSTRY. Silber, F. A.; Weisshaeupl, H. (Vereinigte Oesterreichische Eisen-und Stahlwerke AG, Linz, Austria). Radex Rundsch.; No. 3, 492-499(Jun 1971). (In German).

The use of atomic power for industrial purposes, theoretical aspects of atomic power, and the use of high temperature reactors in the iron and steel industry are discussed. (INIS)

Propulsion and Package Reactors

Refer also to abstracts 15984, 17499, 17508–17517, and 17640.

17478 (AI-AEC-13066) SNAP PROGRAMS BIBLIOGRAPHY. Eggleston, R. R. (ed.). (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT(04-3)-701. 196p. Dep. NTIS $12.00.

An annotated bibliography of documents related to the SNAP Reactor program is arranged according to subject matter. A listing of SNAP program progress reports arranged by project is also presented. A numerical listing of all previously unlisted SNAP reports is also included. (JWR)

17479 (AI-AEC-13071) SUMMARY OF SNAP 8 DEVELOPMENTAL REACTOR (S8DR) OPERATIONS. Felten, L. D.; May, H. D. (Atomics International Div., Canoga Park, Calif. (USA)). 22 Jun 1973. Contract AT(04-3)-701. 83p. Dep. NTIS $6.25.

The SNAP 8 Developmental Reactor (S8DR) achieved criticality on June 22, 1968. Power operation was initiated in January of 1969, and continued throughout the year. Final shutdown was in December of 1969. The reactor logged 6688 hr at nominal 600 kW, and 429 hr at 1000 kW. Total energy release was 4.35×10^6 kWh thermal. (auth)

17480 (AI-AEC-13077) FUEL ELEMENT AND CORE BUNDLE 5-kWe REACTOR THERMOELECTRIC SYSTEM. Felten, L. D.; Moody, E. (Atomics International Div., Canoga Park, Calif. (USA)). 22 Jun 1973. Contract AT(04-3)-701. 179p. Dep. NTIS $11.00.

The design of the core bundle for a 5-kW(e) zirconium hydride reactor is discussed. The design thermal power is 110 kW(t) at 1200°F outlet temperature for 5 years. Most of the thermal, hydraulic, and stress calculations have been completed for the core bundle. Operational stresses for the fuel elements show positive margins of safety. (auth)

17481 (AI-AEC-13084) ZIRCONIUM HYDRIDE FUEL ELEMENT PERFORMANCE CHARACTERISTICS. Lillie, A. F.; McClelland, D. T.; Roberts, W. J.; Walter, J. H. (Atomics International Div., Canoga Park, Calif. (USA)). 19 Jun 1973. Contract AT(04-3)-701. 75p. Dep. NTIS $5.75.

Design of the U–ZrH fueled SNAP compact reactor requires: (1) prediction of the reactivity decrease over the core lifetime, associated with the loss of hydrogen moderator from the fuel elements, and (2) prediction of the anticipated fuel growth, for the particular reactor operating conditions, to assure integrity of the fuel element cladding. Extensive data were obtained during the course of the SNAP Reactor Development Program regarding the hydrogen-retention characteristics of the ceramic-lined fuel element, and regarding the fuel-growth characteristics of the U–ZrH fuel. The ceramic liner was found to be a very effective and highly durable hydrogen barrier. The fuel growth, observed to consist of a rapid early-life growth, followed by a much slower long-term growth, was found to be temperature, flux, and fluence dependent. (auth)

17482 (AI-AEC-13089) SPACE NUCLEAR SYSTEM "SHEATHED" ELECTRICAL CABLES. Summary Report. Donelan, L. E. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT(04-3)-701. 24p. Dep. NTIS $3.25.

A metallic-sheathed electrical cable is being developed for use with the zirconium hydride reactor power system. The positive protection to the conductor, and the insulation, provided by the metallic sheath is expected to increase the cable performance reliability from that of the previously utilized braided-wire-covered cables. Material and design studies

were conducted to select the reference cable configuration. The reference design selected consisted of a single stainless steel clad 0.040-in. diameter conductor, encased within a 0.090-in. diameter stainless steel sheath, with compacted MgO insulation between the conductor and the sheath. Methods of terminating the cable to the actuator and the limit switch were also selected. Preliminary tests have shown that this type of cable will maintain the insulation resistance well above the minimum acceptable level, under long-time exposure to the fabrication, system assembly, and operational environments and conditions. The mechanical properties of the cable, and the termination designs, require further testing and evaluation. (auth)

17483 (AI-AEC-13091) SPACE NUCLEAR SYSTEM THERMOELECTRIC NaK PUMP DEVELOPMENT. Summary Report. Johnson, J. L. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT(04-3)-701. 85p. (NASA-CR-121231). Dep. NTIS $6.25.

The engineering, design, fabrication, and test history of the dual-throat thermoelectric NaK development pump, and the engineering and design status of a similar prototype pump intended for use on the 5-kW(e) Reactor Thermoelectric System are summarized. The history of dc pump development and testing on previous SNAP programs is also summarized. (auth)

17484 (AI-AEC-13102) MATERIALS INTERACTIONS BETWEEN THE THERMOELECTRIC CONVERTER AND THE 5-kwe REACTOR SYSTEM. Ferry, P. B. (Atomics International Div., Canoga Park, Calif. (USA)). 30 Jun 1973. Contract AT(04-3)-701. 72p. (NASA-CR-121230). Dep. NTIS $5.75.

Integration of a compact thermoelectric converter with the 5-kW(e) reactor system requires introduction of Ta-10 W piping into some portion of the primary coolant loop. The accompanying material interaction uncertainties could affect the present system design. These include degradation of the required austenitic-refractory metal transition joint during operation at high temperatures, loss of corrosion resistance, embrittlement by the presence of hydrogen, and loss of design margin by transport of interstitial elements. Analysis and limited experimental evidence indicates that these potential materials interactions can be adequately controlled. It appears that the Group Va refractory metal can be utilized without unacceptable adverse effect on system reliability. (auth)

17485 (N-72-11535) SNAP-8 POWER CONVERSION SYSTEM DESIGN REVIEW. Lopez, L. P. (Aerojet Nuclear Systems Co., Azusa, Calif. (USA)). Jun 1970. 261p. (NASA-CR-72945; AGC-4017). NTIS.

The conceptual design of the SNAP-8 electrical generating system configurations are reviewed including the evolution of the PCS configuration, and the current concepts. The reliabilities of two alternative PCS-G heat rejection loop configurations with two radiator design concepts are also reviewed. A computer program for calculating system pressure loss using multiple-loop flow analysis is included. (STAR)

17486 (N-72-28681) INSTABILITIES IN URANIUM PLASMA AND THE GAS-CORE NUCLEAR ROCKET ENGINE. Final Report. Tidman, D. A. (Versar, Inc., Springfield, Va. (USA)). May 1972. Contract NASw-2231. 79p. (NASA-CR-127480). NTIS.

The nonlinear evolution of unstable sound waves in a uranium plasma is calculated using a multiple time-scale asymptotic expansion scheme. The fluid equations used include the fission power density, radiation diffusion, and the effects of the changing degree of ionization of the uranium atoms. The nonlinear growth of unstable waves is shown to be limited by mode coupling to shorter wavelength waves which are damped by radiation diffusion. This mechanism limits the wave pressure fluctuations in the plasma of a typical gas-core nuclear rocket engine. The instability is thus not expected to present a control problem for this engine. (auth)

17487 (N-73-12698) INVESTIGATION OF GASEOUS NUCLEAR ROCKET TECHNOLOGY. Summary Technical Report. Kendall, J. S. (United Aircraft Corp., East Hartford, Conn. Research Labs). Sep 1972. Contract SNPC-70. 113p. (NASA-CR-129500; L-910905-13). NTIS.

The experimental and theoretical investigations conducted during the period from September 1969 through September 1972 are reported which were directed toward obtaining information necessary to determine the feasibility of the full-scale nuclear light bulb engine, and of small-scale nuclear tests involving fissioning uranium plasmas in a unit cell installed in a driver reactor, such as the Nuclear Furnace. Emphasis was placed on development of RF simulations of conditions expected in nuclear tests in the Nuclear Furnace. The work included investigations of the following: the fluid mechanics and containment characteristics of one-component and two-component vortex flows, both unheated and RF-induction heated; heating of particle-seeded streams by thermal radiation from a dc arc to simulate propellant heating; condensation and separation phenomena for metal-vapor/heated-gas mixtures to provide information for conceptual designs of components of fuel exhaust and recycle systems; the characteristics of the radiant energy spectrum emitted from the fuel region, with emphasis on definition of fuel and buffer-gas region seed systems to reduce the ultraviolet radiation emitted from the nuclear fuel; and the effects of nuclear radiation on the optical transmission characteristics of transparent materials. (auth)

17488 (N-73-12701) ANALYSIS OF A BORON-CARBIDE-DRUM CONTROLLED CRITICAL REACTOR EXPERIMENT. Mayo, W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1972. 27p. (NASA-TM-X-2680). NTIS.

In order to validate methods and cross sections used in the neutronic design of compact fast-spectrum reactors for generating electric power in space, an analysis of a boron-carbide-drum-controlled critical reactor was made. For this reactor the transport analysis gave generally satisfactory results. The calculated multiplication factor for the most detailed calculation was only 0.7-percent Delta k too high. Calculated reactivity worth of the control drums was $11.61 compared to measurements of $11.58 by the inverse kinetics methods and $11.98 by the inverse counting method. Calculated radial and axial power distributions were in good agreement with experiment. (auth)

17489 (N-73-16691) INDUCTION SIMULATION OF GAS CORE NUCLEAR ENGINE. Poole, J. W.; Vogel, C. E. (Humphreys Corp., Concord, N. H.). Feb 1973. Contract NAS3-14416. 44p. (NASA-CR-2155). NTIS.

The design, construction, and operation of an induction heated plasma device known as a combined principles simulator is discussed. This device incorporates the major design features of the gas core nuclear rocket engine such as solid feed, propellant seeding, propellant injection through the walls, and a transpiration cooled, choked flow nozzle. Both argon and nitrogen were used as propellant simulating material, and sodium was used for fuel simulating material. In addition, a number of experiments were conducted utilizing depleted uranium as the fuel. The test program revealed that satisfactory operation of this device can be accomplished over a range of operating conditions and provided additional data to confirm the validity of the gas core concept. (auth)

17490 (NAA-SR-8092) SNAP 8 QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1962. Johnson, C. E. (Ed.). (Atomics International, Canoga Park, Calif.). 20 May 1963. Contract AT(11-1)-Gen-8. 182p. Dep. NTIS $11.25.

Declassified 3 May 1973.

Progress is reported covering the SNAP 8 reactor development program including objectives, design description, system analysis, component development, and system tests. Analysis of the SNAP 8 Experimental Reactor (S8ER) dry critical tests has resulted in slightly increasing the flight reactor fuel element active length. Corresponding geometric changes have been made in the reactor system. The heat transfer and service systems for the S8ER power tests have been installed. All drawings for the SNAP 8 Developmental Reactor Mockup have been completed. (auth)

17491 (NAA-SR-9720) SNAP 10A PRESTARTUP AND STARTUP PERFORMANCE. Drucker, G. S.; Boyle, T. J. (Atomics International, Canoga Park, Calif.). 30 Jun 1964. Contract AT(11-1)-Gen-8. 84p. Dep. NTIS $6.25.

Declassified 17 Apr 1973.

Presented are the results of analyses to determine the thermal behavior of the SNAP 10A system in orbit prior to startup, and the nuclear, thermal, and hydraulic behavior of the system during startup. Parameter studies were made to determine the effects of variations from the nominal design conditions on maximum and minimum system temperatures prior to startup and the severity of the startup transient. Also included are the mathematical models used in the digital and analog computer solutions. The analyses results indicate that the SNAP 10A system will meet its prestartup and startup requirements. (auth)

17492 (ORNL-TM-913) AN EVALUATION OF THE CHEMICAL PROBLEMS ASSOCIATED WITH THE AQUEOUS SYSTEMS IN THE TUNGSTEN WATER MODERATED REACTOR. Griess, J. C.; Jenks, G. H.; Eissenberg, D. M.; Bohlmann, E. G. (Oak Ridge National Lab., Tenn.). Aug 1964. Contract W-7405-eng-26. 88p. Dep. NTIS $6.50.

Declassified 10 Apr 1973.

An evaluation of chemical and corrosion problems involved in the use of aqueous systems (moderator and poison control) in the Tungsten Water Moderated Reactor (TWMR) is presented. A review of available information pertinent to the aqueous systems associated with the TWMR indicates no insurmountable problems that would preclude the use of water as the moderator or a compound dissolved in D_2O as the means of reactivity control. There are, however, problems and information gaps associated with both systems, and these must be resolved before the aqueous systems, particularly the poison control system, can be considered useable in the TWMR. Recommendations for research and development work necessary to further evaluations of the systems are also given. 90 references. (auth)

17493 (ORNL-TM-978) AN EVALUATION OF THE CHEMICAL PROBLEMS ASSOCIATED WITH THE AQUEOUS SYSTEMS IN THE TUNGSTEN WATER MODERATED REACTOR, ADDENDA 1 AND 2. Jenks, G. H.; Bohlmann, E. G.; Griess, J. C. (Oak Ridge National Lab., Tenn.). Mar 1965. 85p. (NASA-CR-54214). Dep. NTIS $6.25.

Declassified 10 Apr 1973.

Additional information is presented concerning the effects and extent of radiolysis of water and solutions in the TWMR. The corrosion of hard-coated 6061-T6 aluminum specimens is studied. (auth)

17494 FUEL ELEMENT OF A THERMAL NUCLEAR REACTOR. Graemer, G.; Peehs, M.; Stehle, H. (to Siemens AG). German Patent 1,614,425. 16 Jul 1970. Filed date 14 Feb 1967. 23p. (In German).

A new fuel element for a thermal reactor, especially for use in a thermionic reactor converter, is described. The jacket is of high-temperature resistant metal, such as Mo or W, and coated particles of fissionable material are placed inside the jacket. The interior surface of the jacket is covered with a ceramic lining. The coated particles are mixed with graphite powder and the free volume of filling is filled with pyrocarbon precipitated from the gaseous phase in the filling. The fuel element serves as the cathode of a thermionic converter and the external surface of the jacket as the emitter surface. The method for the preparation of the fuel element is described. (JSR)

17495 NUCLEAR REACTOR FUEL CHARGING AND DISCHARGING SYSTEM. Jackomis, W. N. (to Secretary of the Air Force). U. S. Patent 3,730,832. 1 May 1973. Filed date 23 Jun 1971. 4p.

A nuclear reactor fuel charging and discharging system is described for colloid core reactors having fuel stored in containers in the shape of cyclone type separators. Valves positioned external to the reactor are opened to permit a gas flow through the containers to carry the nuclear fuel into the reactor cavity through a slot positioned near the periphery of the reactor cavity. A second set of valves positioned external to the reactor are opened, and the first valves are closed to remove the nuclear fuel from the reactor cavity. The nuclear fuel is separated from the gas which carries the fuel to the storage containers in the cyclone type separators. (Official Gazette)

17496 GENERATION OF INDUCTION HEATED, SEEDED HYDROGEN PLASMAS AT ONE ATMOSPHERE PRESSURE. Benns, R. A. Atlanta; Georgia Inst. of Tech. (1972). 156p. University Microfilms Order No. 73-6476.

Thesis (Ph. D.).

The gaseous core nuclear reactor is being developed to produce very hot working fluid gases for advanced power and propulsion systems. In the gaseous core nuclear reactor, a very hot fissioning core radiates thermal energy to the working fluid. For propulsion systems hydrogen would be the working fluid. Hydrogen gas below about 10000°K is transparent to the radiation emitted by the fissioning core, and must be seeded with submicron-sized metallic particles to enhance absorption of thermal energy in the working fluid. Measurements of the extinction parameter of tungsten-hydrogen aerosols have previously been made as a function of wavelength from 2500 Å to 5800 Å at temperatures to 2500°K. At high temperatures (4000 to 5000°K) the seed particles vaporize, resulting in an opacity decrease. At temperatures above about 10000°K the hydrogen itself becomes opaque. The temperature range in which the seed has vaporized, but the hydrogen has not become opaque is known as the seed-hydrogen opacity window. Previously only estimates of the seed vapor opacity, based on theoretical considerations, were available in the region of the seed-hydrogen opacity window. A 125 kilowatt radio frequency induction heater has been designed and constructed to produce tungsten seeded hydrogen plasmas which simulate the working fluid of the gaseous core nuclear reactor. An air cooled plasma torch with flat windows to allow for spectral observation of the plasma has been developed. Initial opacity measurements of the tungsten seeded hydrogen plasmas have been taken by scanning the plasma with a helium-neonlaser, and recording attenuated and non-attenuated laser intensity. These data, which are a function of axial distance from the center of the plasma, are transformed to opacity as a function of radius by an Abel inversion technique. Opacity data have been taken for several tungsten seeded hydrogen plasmas of various tungsten densities. An extinction parameter of 2×10^4 cm^2/gm was measured, which indicates that the seed-hydrogen opacity window is not very transparent and that there should be little difficulty associated with heating the working fluid with thermal radiation in the temperature range of the seed-hydrogen opacity window. (Diss. Abstr. Int., B)

17497 JOINT EVALUATION STUDY BY JAPAN AND GERMANY CONCERNING AN 80,000 HP NUCLEAR CONTAINER SHIP. Kinoshita, M. (Hitachi Shipbuilding and Engineering Co. Ltd., Osaka). Sempaku; 45: No. 8, 42-52(Aug 1972). (In Japanese).

The flow of goods over the world increases steadily, and the prospect is that the demand of tonnage will increase in the future. With the increasing number of ships and large ships, the rapid increase of ship speed requires high output engines. To meet this situation, early use of nuclear merchant ships becomes necessary, and prospective demand for the nuclear ships in Japan was published in "Long-term review regarding nuclear ships" in 1971. It is expected that more than 200 nuclear container ships and large nuclear tankers will be in use by 2,000 A.D. in Japan. In 1970, representatives from Japan and Germany conferred on board the N.S. Otto Hahn, and decided to evaluate the technical and economical problems of nuclear container ships. Since then, trial design and economical evaluations have been made. The container ship was an 80,000 hp ship used for the Europe–Far East route via Panama. This ship was designed as a nuclearized ship, and the problems were examined. A critical obstacle in the construction of nuclear ships is the production of the reactors, and cost reduction must be achieved by the standardization and mass production of their components. Improvement of core design and better neutron economy, optimization of a common structure for hull and containment, and collision-resistant structure must be advanced. Weight and cost reduction in the radiation shield and waste disposal are necessary. Laws and regulations must be more practical. (JA)

17498 NUCLEAR SHIP DEVELOPMENT IN JAPAN. Sasaki, S. (Japan Nuclear Ship Development Agency, Tokyo). Nucl. Eng. Int.; 18: No. 206, 558-560(Jul 1973).

The design of the PWR nuclear ship Mutsu is described and main parameters are given. Port facilities are briefly outlined. Reference is made to the researches of various Japanese organizations into nuclear propulsion. It is concluded that among the studies required are methods of reducing the number of ancilliary facilities needed for a nuclear ship, standardization in construction and operation, and improvement in conditions for entry into foreign ports. The future prospects are considered to be very good. (UK)

Reactor Safety and Environmental Aspects

Refer also to abstracts 15480, 15489, 15492, 15712, 17350, 17379, 17625, and 17643.

17499 (AI-AEC-13074) OPERATIONAL HAZARDS EVALUATION FOR 5-kW(e) REACTOR THERMOELECTRIC SYSTEM GROUND TEST. Tuttle, R. J. (Atomics International Div., Canoga Park, Calif. (USA)). 11 Jun 1973. Contract AT(04-3)-701. 34p. Dep. NTIS $3.75.

Selected reactor accidents, analyzed by a digital computer simulation program, and the requirements for scram protection, are discussed. Prevention of undesirable interaction between the control and safety systems is described. Operational limitations on segment positions are presented that afford adequate shutdown protection throughout the reactor lifetime. Potential operator errors and equipment malfunctions and failures are discussed. (auth)

17500 (BC-TOP-4(Add.1)) ADDENDUM 1 TO SEISMIC ANALYSIS OF STRUCTURES AND EQUIPMENT FOR NUCLEAR POWER PLANTS. (Bechtel Power Corp., San Francisco, Calif. (USA)). Apr 1973. 82p.

An addendum is provided which up-dates information and corrects typographical errors in a previous topical report on the seismic analysis of equipment and structures for nuclear power plants. (LCL)

17501 (COO-2244-1(Rev.1)) STEAM–WATER MIXING TEST PROGRAM. Task D: Formal Report for Task A, 1/5 Scale Broken Loop. Lowe, P. A.; Brodrick, J. R.; Burchill, W. E. (Combus-

tion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Mar 1973. Contract AT(11-1)-2244. 104p. (CENPD-65(Rev.1)). Dep. NTIS $7.25.

The test program and experimental results for steam and emergency core cooling water interaction in the broken cold leg piping of a model of a pressurized water reactor are described. The program background and objectives are presented. The test apparatus and testing techniques are discussed. Raw data and reduced data are presented in detail. (auth)

17502 (FIND-50286) FIND: INDIAN POINT STATION, UNIT 3. Raleigh, H. D. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). Jul 1973. 38p. Dep. NTIS $4.00.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames of the microfiche. (FS)

17503 (GEAP-13923-2) SODIUM-COOLED REACTORS SAFETY ENGINEERING PROGRAM. Second Quarterly Report, November 1972–January 1973. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Feb 1973. Contract AT(04-3)-893. 32p. Dep. NTIS $4.00.

The purpose of the project is: (1) to bring into sharp focus both the requirements or needs for specific technical information related to LMFBR safety, and the results of previous studies, wherever performed; (2) to recommend to AEC-RDT a course of action which will provide the information still required. The activity during November and December 1972 and January 1973 is reported. (auth)

17504 (JAPFNR-102) COMPUTER CODE FOR SAFETY ANALYSIS. 1. Sodium Boiling (Single Bubble Model) NAIS-P. Haga, K.; Takahashi, T.; Kikuchi, Y.; Hori, M. (Power Reactor and Nuclear Fuel Development Corp., Oarai (Japan). Oarai Engineering Center). Aug 1972. 84p. (PNC-N-941-72-9). Dep. NTIS (U. S. Sales Only) $6.25.

The NAIS-P computer code for sodium boiling analysis was prepared based on the single bubble model in the single channel. The main purpose of the code is to check the validity of the model by making comparison of the calculated results with the data obtainable from the boiling test by the use of Sodium Transient-Boiling Test Equipment installed in Fast Reactor Safety Testing Laboratory. Consequently, particular efforts were made in simulating the structure of the test section and its surroundings of the equipment as far as possible. The channel was divided into 4 regions of various cross sections and the bypass effect was also introduced. The channel can be divided into up to 40 meshes in its axial direction and the heating section can be divided in its radial direction into one mesh of the heater and up to 5 meshes in the cladding. Heat input increase, flow rate decrease, and channel blockage can be simulated as factors causing boiling. The test run shows no trouble in numerical calculation, indicating full reliability of the present code. The model of the code, basic equations, method of calculation, code structure, results of test run, and comparison with data are described. (auth)

17505 (JAPFNR-111) PRESENT STATUS OF THE RESEARCH AND DEVELOPMENT ON THE FBR SAFETY. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Apr 1973. 9p. (PNC-N-241-73-27(4)). Dep. NTIS (U.S. Sales Only) $3.00.

Research related to safety of sodium cooled fast breeder reactors is briefly summarized. (JWR)

17506 (MRR-89) BRUJET: A BLOW-DOWN PROGRAM FOR BOILING WATER REACTORS WITH JET PUMPS. Steinhoff, F. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Sep 1971. 61p. (In German). INIS.

A mathematical model is developed for the recirculation loop of a boiling water reactor with jet pumps. This model is used for the blowdown code BRUJET which simulates the steam line break and the recirculation line break before or behind the recirculation pump. The code is applied to numerical calculations for a test reactor. (INIS)

17507 (MRR-92) LONG-TERM MODEL FOR THE CALCULATION OF THE THERMOHYDRAULIC EVENTS DURING A LOSS OF COOLANT ACCIDENT IN THE PRIMARY CIRCUIT OF A NUCLEAR REACTOR. Liesch, K. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Nov 1971. 16p. (In German). INIS.

The state of development of a computer code (long term model) called BRUCH-DL is discussed. This code describes the thermohydraulic processes within the primary circuit of a reactor including temperature distribution inside the core. The Algol version of a code BRUCH-D was used as a basis for BRUCH-DL. The changes made to the codes BRUCH-D and BRUCH-S are described. An attempt to introduce heat transfer correlations was made. (INIS)

17508 (N-73-11694) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 1. Base Nuclear System Safety. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 44p. (NASA-CR-123842; DOC-72-SD-4201-1-1). NTIS.

The mission and terrestrial nuclear safety aspects of future long duration manned space missions in low earth orbit are discussed. Nuclear hazards of a typical low earth orbit Space Base mission (from natural sources and on-board nuclear hardware) have been identified and evaluated. Some of the principal nuclear safety design and procedural considerations involved in launch, orbital, and end of mission operations are presented. Areas of investigation include radiation interactions with the crew, subsystems, facilities, experiments, film, interfacing vehicles, nuclear hardware and the terrestrial populace. Results of the analysis indicate: (1) the natural space environment can be the dominant radiation source in a low earth orbit where reactors are effectively shielded, (2) with implementation of safety guidelines the reactor can present a low risk to the crew, support personnel, the terrestrial populace, flight hardware and the mission, (3) ten year missions are feasible without exceeding integrated radiation limits assigned to flight hardware, and (4) crew stay-times up to one year are feasible without storm shelter provisions. (auth)

17509 (N-73-11696) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 3. Reactor System Preliminary Nuclear Safety Analysis. Part 1. Reference Design Document (RDD). Final Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 99p. (NASA-CR-123844; DOC-72-SD-4201-3-1(Vol.3)(Pt.1)). NTIS.

The Reference Design Document, of the Preliminary Safety Analysis Report (PSAR)–Reactor System provides the basic design and operations data used in the nuclear safety analysis of the Reactor Power Module as applied to a Space Base program. A description of the power module systems, facilities, launch vehicle and mission operations, as defined in NASA Phase A Space Base studies is included. Each of two Zirconium Hydride Reactor Brayton power modules provides 50 kW(e) for the nominal 50 man Space Base. The INT-21 is the prime launch vehicle. Resupply to the 500 km orbit over the ten year mission is provided by the Space Shuttle. At the end of the power module lifetime (nominally five years), a reactor disposal system is deployed for boost into a 990 km high altitude (long decay time) earth orbit. (auth)

17510 (N-73-11697) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 3. Reactor System Preliminary Nuclear Safety Analysis. Part 2. Accident Model Document (AMD). Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 309p. (NASA-CR-123839; DOC-72-SD-4201-3-2(Vol.3)(Pt.2)). NTIS.

The Accident Model Document is one of three documents of the Preliminary Safety Analysis Report (PSAR)–Reactor System as applied to a Space Base Program. Potential terrestrial nuclear hazards involving the zirconium hydride reactor-Brayton power module are identified for all phases of the Space Base program. The accidents/events that give rise to the hazards are defined and abort sequence trees are developed to determine the sequence of events leading to the hazard and the associated probabilities of occurrence. Source terms are calculated to determine the magnitude of the hazards. The above data is used in the mission accident analysis to determine the most probable and significant accidents/events in each mission phase. The only significant hazards during the prelaunch and launch ascent phases of the mission are those which arise from criticality accidents. Fission product inventories during this time period were found to be very low due to very limited low power acceptance testing. (auth)

17511 (N-73-11699) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 3. Reactor System Preliminary Nuclear Safety Analysis. Part 3. Nuclear Safety Analysis Document (NSAD). Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 142p. (NASA-CR-123846; DOC-72-SD-4201-3-3(Vol.3)(Pt.3)). NTIS.

Nuclear safety analysis as applied to a space base mission is presented. The nuclear safety analysis document summarizes the mission and the credible accidents/events which may lead to nuclear hazards to the general public. The radiological effects and associated consequences of the hazards are discussed in detail.

The probability of occurrence is combined with the potential number of individuals exposed to or above guideline values to provide a measure of accident and total mission risk. The overall mission risk has been determined to be low with the potential exposure to or above 25 rem limited to less than 4 individuals per every 1000 missions performed. No radiological risk to the general public occurs during the prelaunch phase at KSC. The most significant risks occur from prolonged exposure to reactor debris following land impact generally associated with the disposal phase of the mission where fission product inventories can be high. (auth)

17512 (N-73-11700) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 4. Space Shuttle Nuclear System Transportation. Part 1. Space Shuttle Nuclear Safety. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 196p. (NASA-CR-123847; DOC-72-SD-4201-4-1(Vol.4)(Pt.1)). NTIS.

An analysis of the nuclear safety aspects (design and operational considerations) in the transport of nuclear payloads to and from earth orbit by the space shuttle is presented. Three representative nuclear payloads used in the study were: (1) the zirconium hydride reactor Brayton power module, (2) the large isotope Brayton power system and (3) small isotopic heat sources which can be a part of an upper stage or part of a logistics module. Reference data on the space shuttle and nuclear payloads are presented in an appendix. Safety oriented design and operational requirements were identified to integrate the nuclear payloads in the shuttle mission. Contingency situations were discussed and operations and design features were recommended to minimize the nuclear hazards. The study indicates the safety, design and operational advantages in the use of a nuclear payload transfer module. The transfer module can provide many of the safety related support functions (blast and fragmentation protection, environmental control, payload ejection) minimizing the direct impact on the shuttle. (auth)

17513 (N-73-11701) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 5. Nuclear System Safety Guidelines. Part 1. Space Base Nuclear Safety. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 217p. (NASA-CR-123848; DOC-72-SD-4201-5-1(Vol.5)(Pt.1)).

The design and operations guidelines and requirements developed in the study of space base nuclear system safety are presented. Guidelines and requirements are presented for the space base subsystems, nuclear hardware (reactor, isotope sources, dynamic generator equipment), experiments, interfacing vehicles, ground support systems, range safety and facilities. Cross indices and references are provided which relate guidelines to each other, and to substantiating data in other volumes. The guidelines are intended for the implementation of nuclear safety related design and operational considerations in future space programs. (auth)

17514 (N-73-11702) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 5. Nuclear System Safety Guidelines. Part 2. Space Shuttle/Nuclear Payloads Safety. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 130p. (NASA-CR-123843; DOC-72-SD-4201-5-2(Vol.5)(Pt.2)). NTIS.

The design and operations guidelines and requirements developed in the study of space shuttle nuclear system transportation are presented. Guidelines and requirements are presented for the shuttle, nuclear payloads (reactor, isotope-Brayton and small isotope sources), ground support systems and facilities. Cross indices and references are provided which relate guidelines to each other, and to substantiating data in other volumes. The guidelines are intended for the implementation of nuclear safety related design and operational considerations in future space programs. (auth)

17515 (N-73-11703) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 6. Space Base Nuclear System Safety Plan. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 72p. (DOC-72-SD-4201-6(Vol.6)). NTIS.

A qualitative identification of the steps required to assure the incorporation of radiological system safety principles and objectives into all phases of a manned space base program is presented. Specific areas of emphasis include: (1) radiological program management, (2) nuclear system safety plan implementation, (3) impact on program, and (4) summary of the key operation and design guidelines and requirements. The plan clearly indicates the necessity of considering and implementing radiological system safety recommendations as early as possible in the development cycle to assure maximum safety and minimize the impact on design and mission plans. (auth)

17516 (N-73-11704) MANNED SPACE FLIGHT NUCLEAR SYSTEM SAFETY. Volume 7. Literature Review. Part 1. Literature Search and Evaluation. Final Report. (General Electric Co., Philadelphia, PA. Missile and Space Div.). Jan 1972. Contract NAS8-26283. 78p. (NASA-CR-123850; DOC-72-SD-4201-7-1(Vol.7)(Pt.1)). NTIS.

A review of the literature used in conducting the manned space flight nuclear system safety study is presented. The objectives of the presentation are to identify and evaluate for potential application to study the existing related literature and to provide the information required to include the related literature in the NASA Aerospace Safety Research and Data Institute. More than 15,000 documents were evaluated and identification forms were prepared for 850 reports. (auth)

17517 (N-73-16641) 810 FT/SEC SOIL IMPACT TEST OF A 2 FOOT DIAMETER MODEL REACTOR CONTAINMENT SYSTEM. Puthoff, R. L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec 1972. 22p. (NASA-TM-X-68180; E-7275). NTIS.

A soil impact test was conducted on an 880-pound 2-foot diameter sphere model. The impact area consisted of back filled desert earth and rock. The impact generated a crater 5 feet in diameter by 5 feet deep. It buried itself a total of 15 feet—as measured to the bottom of the model. After impact the containment vessel was pressure checked. No leaks were detected nor cracks observed. (auth)

17518 (NP-19778) FINAL REPORT TO OREGON NUCLEAR AND THERMAL ENERGY COUNCIL ON NAVAL AIRCRAFT ACCIDENT RISKS AT THE CARTY SITE. Cornell, C. A. (Massachusetts Inst. of Tech., Cambridge). 31 May 1973. 44p.

The annual probability of a military plane utilizing the Navy's Boardman Range impacting into the Carty site proposed for a nuclear power plant complex is estimated. (HDR)

17519 (ORNL-NSIC-111) REACTOR PROTECTION SYSTEMS: PHILOSOPHIES AND INSTRUMENTATION REVIEWS FROM NUCLEAR SAFETY. Haden, E. W. (ed.) (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 270p. Dep. NTIS $15.00.

Aspects of the design philosophies for reactor protection systems are summarized. A rationale of the doctrines and philosophies governing the design of the reactor trip systems is developed. A composite of the ideas previously expressed by many authors and of those promulgated by the industry standards is given. These separate views and proposed tenets are set into a single composition in an effort to collate the significant concepts. Many routes to a protection system design are shown, and it is not necessary that all designs be identical to perform their missions satisfactorily. (auth)

17520 (RRA-M-7202) BOUNDARY DOSE RATES DUE TO GAMMA RAYS AT POWER REACTOR SITES. Wells, M. B.; Collins, D. G.; Neuendorf, W. P. (Radiation Research Associates, Inc., Fort Worth, Tex.). 12 Nov 1972. 21p. (CONF-721109-22).

From international conference on nuclear solutions to world energy problems; Washington, District of Columbia, USA (12 Nov 1972).

Site boundary dose rates are calculated for γ radiation from water cooled power reactors. The SKYSHINE computer program for evaluating the effects of shielding and structure configuration on γ radiation dose rate at given positions outside the structures is described. 12 references. (DCC)

17521 (UNI-15) OPERATING SAFETY LIMITS: N REACTOR. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 1 Jun 1973. 66p. Dep. NTIS $5.50.

17522 (WASH-1254) RECOMMENDATIONS FOR SHAPE OF EARTHQUAKE RESPONSE SPECTRA. (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). Feb 1973. Contract AT(49-5)-3011. 210p. GPO $3.60.

A number of significant earthquake records are analyzed in order to develop "standardized" design spectrum shapes to be used in the seismic design of nuclear power plant facilities. Because earthquakes are complex phenomena, and since it is not possible to exactly predict the nature of seismic ground motions, statistical analyses of recorded ground motions must be used. The major findings and recommendations from the studies based on such statistical analyses, along with brief discussions of the data and the analytical approaches used, are discussed. 26 references. (auth)

17523 (ZJE-130) EVALUATION OF CONSEQUENCES OF AN ATOMIC POWER PLANT PRIMARY CIRCUIT RUPTURE. Hulovec, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1972. 53p. Dep. NTIS (U.S. Sales Only) $4.75.

Leaks in a gas cooled reactor primary circuit may result in serious consequences for further operation. Even if the probability of its occuring is very low, ways and means must be provided to limit these implications. To analyze the consequences of a rupture of the KS-150 reactor gas piping, a model has been worked out capable of being programmed on general-purpose AP-3M and APO-16 analog computers. This program, referred to as "APPORT A-1," enables one to determine the velocity of gas flowing out of the damaged piping and transient dynamical forces acting on reactor internals, and permits evaluation of the effect of additional throttling elements to reduce gas discharge. (auth)

17524 REACTOR SAFETY. Franzen, F. (Institut fuer Reaktorsicherheit der Technischen Ueberwachungsvereine eV, Cologne). VDI (Ver. Deut. Ing.) Z.; 115: No. 6, 443-449(1973). (In German).

Information on reactor safety is presented concerning licensing procedures, guidelines, research programs, operating experience, pressure vessels, emergency core cooling, external influences, and civilian influences. (GE)

17525 AUTOCATALYSIS DURING FAST REACTOR DISASSEMBLY. Boudreau, J. E.; Erdmann, R. C. (Univ. of California, Los Angeles). Nucl. Sci. Eng.; 51: No. 2, 206-222(Jun 1973).

Secondary criticality resulting from massive core rearrangement is discussed where the material dynamics results from either mild or strong initial excursions. Diffusion theory is used to study the effect of moving boundaries on the flux, and to study the effect of internal fuel rearrangement on k_{eff}. Numerical transport methods are used to make accurate determinations of k_{eff} for complicated fuel configurations arising from disassembly calculations. It is concluded that secondary criticality may occur from fuel rearrangement, but that it is unlikely in most cases. Variations in core height/diameter ratio, zonal enrichment, and overall size can change the tendency for autocatalysis significantly. (auth)

17526 NUCLEAR SAFETY. Cottrell, W. B.; Jordan, W. H.; Blakely, J. P. A Technical Progress Review Published for the Technical Information Center, USAEC. Oak Ridge, TN; Oak Ridge National Laboratory (1973). 104p. GPO $0.60.

Eight separate abstracts have been prepared on significant developments in the field of nuclear safety limited to the analysis and control of hazards associated with nuclear reactors, operations involving fissionable materials, and the products of nuclear fission and their effects on the environment. (FS)

For abstracts of individual papers see: 15727, 17527–17532, and 17641.

17527 REGULATION OF THE ENVIRONMENTAL EFFECTS OF NUCLEAR POWER PLANTS. Davis, J. P. (Consolidated Edison Co., New York). Nucl. Safety; 14: No. 3, 165-181(1973).

The radiological and nonradiological effects of nuclear power generation on the environment and the means for their regulation are discussed along with some related cases and controversies. Proposals for improvements through changes in procedures and new legislation are also examined. (auth)

17528 PROBABILITY OF DAMAGE TO NUCLEAR COMPONENTS DUE TO TURBINE FAILURE. Bush, S. H. (Battelle Pacific Northwest Labs., Richland, WA). Nucl. Safety; 14: No. 3, 187-205(1973).

The probability of significant damage to critical components of a nuclear reactor system due to turbine failure has been assessed by determining the combined probabilities of turbine failure and ejection of an energetic missile (P_1), on the basis of 70,000 turbine-years of operation; a missile from the turbine striking a critical component (P_2); and significant damage occurring to the component (P_3). The overall probability (P_4) is an indication of how much the nuclear plant designer needs to be concerned with the turbine missile problem. Turbine failures were reviewed to establish relevance with regard to current practice in design, fabrication, and operation of nuclear steam turbines. If P_1 is 10^{-4} per year, P_2 is 10^{-3} for strike on a 1200-ft^2 area, and $P_3 \rightarrow 1$, then P_4 is approximately 10^{-7}; if P_2 increases, evaluation of P_3 becomes necessary. (auth)

17529 FACTORS LIMITING PROMPT-CRITICAL EXCURSIONS IN IRRADIATED FAST REACTOR CORES. Teague, H. J.; Mather, D. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Safety; 14: No. 3, 201-205(1973).

Preliminary calculations are reported which illustrate how pressures from fission products in irradiated fuel would drastically reduce the explosive energy release in a fast reactor subjected to a fast reactivity ramp. Additional emphasis is put on the reduction of damaging effects due to rapid generation of sodium vapor for three reasons: lower fuel temperatures at core disassembly, less violent internal disassembly processes, and gas blanketing of fuel particles. (auth)

17530 STANDBY EMERGENCY POWER SYSTEMS. Part I. The Early Plants. Hagen, E. W. Nucl. Safety; 14: No. 3, 206-219(1973).

Availability of reliable standby or emergency power systems has always been a prime consideration in station design, beginning with the early nuclear reactor power plants. The documented operating experiences were reviewed for the station off-site and on-site standby, emergency a-c power sources, and the battery systems. Part 1 discusses these systems for the generating reactors commissioned about 1959–1967. The ability of these systems to perform satisfactorily when needed has been very good for the early plants, but the ability to perform satisfactorily at any given time was something less. However, with the advancement of regulatory design guides and industry standards, the reliability is expected to continue to be good and the availability to be improved. In the later plants, to be discussed in Part 2, with standardized and modularized designs, these efforts and effects will become apparent through better use, testing, and documentation. (auth)

17531 SAFETY-RELATED OCCURRENCES REPORTED IN DECEMBER 1972 AND JANUARY 1973. Casto, W. R. (comp.). Nucl. Safety; 14: No. 3, 226-229(1973).

17532 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Sheldon, M. (ed.). Nucl. Safety; 14: No. 3, 230-235(1973).

17533 DESIGN CRITERIA OF ASEISMIC SUPPORT FOR NUCLEAR POWER STATION PIPING. Tamai, T.; Yamadera, M. (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo). Ishikawajima-Harima Giho; 13: No. 1, 50-56(Jan 1973). (In Japanese).

Nuclear power piping is divided into four aseismic design classes according to the degree of importance for plant safety and is designed to meet the requirements specified for each class. Generally, dynamic analysis is necessary for the important aseismic design classes, but the "Maximum Aseismic Span Method" was established as a simplified technique to replace the expensive dynamic analysis. The use of the "Maximum Aseismic Span Method" is described. Structural design criteria of the aseismic support was established by theoretical means, but it used to depend on personal experience. The above analysis and design criteria are discussed in detail. (auth)

17534 THERMAL EXPLOSION HAZARDS. Witte, L. C.; Cox, J. E. (Univ. of Houston, TX). Advan. Nucl. Sci. Technol.; 7: 329-364(1973).

The thermal explosion hazards associated with molten fuel-coolant interactions in nuclear reactors are discussed. Topics covered include the history of explosive vapor formation incidents, early controlled experiments, recent fragmentation investigations, identification of triggering mechanisms, and the theoretical prediction of pressure generation. (JWR)

17535 MODELS FOR THE TREATMENT OF HYPOTHETICAL ACCIDENTS IN SODIUM COOLED FAST BREEDER REACTORS. Kuczera, B.; Struwe, D.; Wirtz, P. (Kernforschungszrentrum, Karlsruhe, Ger.). KFK Nachr.; 5: No. 1, 15-22(1973). (In German).

Within the framework of the licensing procedure of the SNR-300 two accident chains are discussed: reactivity accident and simultaneous failure of all pumps assuming that the first and second shutdown system do not respond. (GE)

17536 PUBLIC UNDERSTANDING AND ACCEPTANCE OF NUCLEAR ENERGY IN JAPAN. Adkins, B. (European Nuclear Energy Agency, Paris). Nucl. Eng. Int.; 18: No. 206, 562-565 (Jul 1973).

Some aspects of problems relating to public understanding and acceptance of nuclear energy are discussed, and actions undertaken in Japan to counteract public opposition are noted. The importance of methods of communication and education, of the existence of impartial official committees concerned with health and safety criteria, the attitude of the utilities and constructors in promoting public confidence, and the personal approach in press relations are stressed. (UK)

17537 ENVIRONMENTAL PROBLEMS IN THE F.R. GERMANY. Limiting the Discharge of Airborne Radioactive Effluents in Regions of High Nuclear Power Plant Density. Schwarzer, W. (Technische Ueberwachungsvereine eV, Cologne). At. Jap., Suppl.; 16: No. 4, 71-94(Apr 1972).

Presently there are 12 nuclear power plants operating, under construction, or at the advanced stage of planning, all of them on a part of a river which is 75 km long. In a situation like this, it is not adequate to treat nuclear power plants as a single isolated source. The setting of limits for the discharge of radioactivity into the air from nuclear power plants is discussed. A brief out-

line of the radiological protection guidelines, as they are presently used in the Federal Republic of Germany, is given. The technical guidelines are used to judge admissibility of the discharge limit. In order to calculate the dose in regions with many nuclear power plants, three different source patterns are adopted. In case of high concentration of nuclear power plants, activity release rate for the individual source as compared to the maximum admissible value for a single isolated power plant has to be reduced if the distance between individual sites is less than 20 kilometers. Expected release of radioactivity into the air from the nuclear power plants is extremely low, and much lower than the "admissible" release as derived from the radiation protection guidelines. Operation of commercial reprocessing plants is not admissible in regions where nuclear power plants exist or are planned. (JA)

17538 ENVIRONMENTAL IMPACT OF NUCLEAR POWER DEVELOPMENT. Chernilin, Y. F. (International Atomic Energy Agency, Vienna). At. Jap., Suppl.; 16: No. 4, 95-114(Apr 1972).

It is expected that total world electrical capacity will grow from the present 1100 gigawatts to an estimated 11000 gigawatts by the year 2010. During the same period, nuclear capacity is expected to increase from 24 gigawatts to 8300 gigawatts. The environmental effects of nuclear power generation are associated with the generation of radioactivity and release of excess heat. The international aspect of atmospheric pollution by radioactive material is stressed with regard to noble gases such as krypton-85. One of the factors influencing the impact of nuclear power on the environment is the selection of sites for nuclear power plants. Another important aspect is the possibility of accidents leading to the release of radioactive materials to the environment. In the present 800 reactor-years of operation experience, there has been no accident that has resulted in the overexposure of the public to radiation. In almost all parts of the world, additional energy is needed for obtaining improved standards of nutrition, housing, clothing, public health, and so on. In this situation, the decision is not whether the additional energy should be produced, but how it can best be produced. The technology required to prevent accidents and to mitigate their consequence is fundamental to the design of nuclear installations to afford maximum protection of the environment. (JA)

17539 US EXPERIENCE IN ENVIRONMENTAL AND PUBLIC ACCEPTANCE ASPECTS OF NUCLEAR POWER. Doub, W. O. (Atomic Energy Commission, Washington, DC). At. Jap., Suppl.; 16: No. 5, 3-34(May 1972).

Environmental and public acceptance aspects of nuclear power are important problems around the world. Most developing nations recognize that energy in general, and nuclear power in particular, will play an increasingly vital role in their future growth. They realize that such growth must be planned to be compatible with environmental needs, and that growth of nuclear power must be thoughtfully and carefully planned and controlled to conform to those needs. Dangerous effects of low-level radiation are pointed out, such as increase in cancer in general population and in genetic defects and infant mortality. The present maximum permissible dose is described, and radiation released must be kept "as low as practicable." As to nuclear safety and accidents, it is reported that numerous risk-benefit studies indicate that living with nuclear plants offers smaller risks than risks associated with using all technologies and modern conveniences of our industrial society. Need for quality assurance to achieve safety and reliability is emphasized. The emergency core cooling systems increase nuclear safety and reliability. Problems of waste management and thermal effect and siting are described, and the Calvert Cliffs case and changing thoughts of Atomic Energy Commission on reactor licensing are described in detail. (JA)

17540 PROCESS FOR SIMULATION OF NUCLEAR REACTOR ACCIDENTS. Dumm, K. (to Interatom). German Patent 1,956,970. 19 May 1971. Filed date 13 Nov 1969. (In German).

A process is described for the simulation of nuclear reactor accidents in which the fuel elements are exposed to unallowable high temperatures. The models of fuel elements contain known mixtures of aluminum and metallic oxides. The high temperatures cause these mixtures to burn. (TSS)

17541 FLOATING NUCLEAR POWER PLANTS FOR OFFSHORE SITING. Collier, A. R.; Nichols, R. C. (Offshore Power Systems, Jacksonville, FL). J. Inst. Nucl. Eng.; 14: No. 2, 42-46(Mar 1973).

Offshore siting of nuclear power plants will permit them to be located nearer load centers without competing for valuable land. The combination of a floating platform-mounted plant manufactured in a shipyard-type facility and an offshore site protected by a breakwater provides advantages in site acquisition, site development, and plant construction. The offshore nuclear plant also offers significant environment benefits. To fully exploit the offshore nuclear plant concept, Offshore Power Systems, a joint enterprise of Westinghouse and Tenneco, has been formed to manufacture the floating plants. Commitments for the first two offshore plants have been received. However, additional orders from other utilities will be required if the enterprise is to be an on-going success for both electric utility industry and the plant builder. (auth)

17542 TILT: A DIGITAL SIMULATION PROGRAM FOR THE STUDY OF HYDRODYNAMIC PROCESSES AND CORE HEAT-UP OF A BOILING WATER PRESSURE TUBE REACTOR DURING TRANSIENT CONDITIONS. Magni, A. (CISE, Segrate, Italy). Energ. Nucl. (Milan); 20: No. 5, 293-301(May 1973).

The TILT digital program was developed to simulate the nuclear, thermal, and hydrodynamic behavior of the CIRENE plant (boiling water pressure tube reactor) during transient conditions resulting from process perturbations and accidents. The plant schemes considered in the program include the most important components of the heat transport primary circuit with its auxiliary, control, and safety systems. TILT is also able to consider different channel geometries. The analytical description uses a lumped-parameter scheme with integration of balance equations by a finite-difference method. The coolant model involves local thermodynamic equilibrium and space-time dependent slip ratio for two-phase flow; furthermore this model deals with transient heat transfer including dryout and rewetting, thus allowing also some investigations of such conditions. The computed coolant mass content and pressure transients show a satisfactory agreement with some blowdown experimental tests. The code is written in FORTRAN V for the UNIVAC-1108 computer. (auth)

17543 NUCLEAR POWER, ENVIRONMENT, AND SAFETY. Hegerman, O. Bygg; 21: No. 4, 36: 46(3 May 1973). (In Norwegian).

Based on Lindell and Löfveberg's book, "Nuclear Power, Mankind and Safety," published in Sweden in 1972, and Norges Vassdrags- og Elektrisitetsvesen's informative brochures published this year in Norway, the need for emphasizing the positive sides of nuclear power to the public and of placing the comprehensive safety measures in perspective, in order to allay public anxiety, is stressed. This is especially the case with regard to thermal pollution, and experience not only from power plants but from coastal volcanic eruptions, with longterm heating of the sea, as at Jan Mayen and Surtsey should be documented. (NO)

17544 NUCLEAR SAFETY. Volume 14, No. 4. Cottrell, W. B.; Jordan, W. H.; Blakely, J. P. A Technical Progress Review Published for the Technical Information Center, USAEC. Oak Ridge, TN; Oak Ridge National Laboratory (1973). 146p. GPO $0.60.

From TIC; US.

Separate abstracts were prepared for each of the 10 papers included. (JWR)

For abstracts of individual papers see: 15489, 15512, 17545–17550, 17625, and 17645.

17545 PRESSURIZED-WATER-REACTOR LOSS-OF-COOLANT ACCIDENTS BY HYPOTHETICAL VESSEL RUPTURE. Doan, P. L.; Lanning, D. D.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). Nucl. Safety; 14: No. 4, 291-304(1973).

The unlikely loss of coolant by some types of postulated pressure-vessel ruptures in a large, four-loop, 2758-MW(t) pressurized-water reactor has been studied to assess the relative importance and consequences of principal blowdown processes. The computer codes WHAM and RELAP3 have been employed as the principal tools of analysis. A large number of computer runs have been made with varying parameters such as break time, break location, break size, fuel-cladding gap conductance, emergency core-cooling injection modes, void coefficients, and phase-separation models. Clear patterns are observed on the asymptotic behavior of many blowdown parameters. (auth)

17546 PHENOMENOLOGICAL RESEARCH IN LMFBR ACCIDENT ANALYSIS. Kelber, C. N. (Argonne National Lab., IL). Nucl. Safety; 14: No. 4, 304-314(1973).

Current needs for, and programs of, phenomenological research applied to problems in accident analysis of liquid-metal-cooled fast breeder reactors are reported. This survey is restricted to phenomena involved in analysis of hypothetical accidents: sodium voiding-coolant dynamics; fuel dynamics; fuel-failure propagation; fuel–coolant interaction; postaccident heat removal; vessel and plug response; sodium fires and aerosols; and fission-product transport. Reported for each case are the current need, the status, the current program, and the ultimate objective of the applicable research. The survey indicates that in the relatively near term an improved basis for describing and predicting the course of an accident will probably be developed. It is much less certain to

what extent it will be possible to factor this understanding into plant design in such a way as to decrease the need for strong containments. An advanced testing program requiring much larger scale tests may be needed. (auth)

17547 DENSIFICATION OF REACTOR FUELS. Culbert, W. H. Nucl. Safety; 14: No. 4, 356-361(1973).

The movement of fuel as a consequence of densification was determined to be the cause for "collapse" of the fuel cladding in a number of pressurized-water reactors. Cladding collapse presented at unevaluated configuration for heat removal in both normal and accident situations. On Nov. 14, 1972, the Regulatory Staff of the U. S. Atomic Energy Commission issued its Technical Report on Densification of Light-Water Reactor Fuels. On Feb. 2, 1973, the Staff issued the report entitled Additional Testimony on Point Beach 2 Nuclear Plant in Regard to Fuel Densification and Its Effects. Summaries of both of these AEC reports are presented along with the bibliography included with the November 14 report. (auth)

17548 ACTIVITY CONFINEMENT AND DECONTAMINATION AFTER FAILURE OF AN Sb–Be SOURCE ROD. Joseph, J. W. Jr.; Little, J. W. Jr. (E. I. du Pont de Nemours and Co., Aiken, SC). Nucl. Safety; 14: No. 4, 362-372(1973).

Antimony in an irradiated source rod melted while the rod was suspended in air in the K reactor room at the Savannah River Plant. The failure released about 85,000 Ci of activity, which was distributed in the reactor room and the confinement filters in the ventilation exhaust system. The confinement filters prevented a significant activity release; only 3 mCi escaped to the environs, and no decontamination was required outside the reactor building. Decontamination of the reactor room and replacement of the contaminated filter compartments required about $3\frac{1}{2}$ months before the reactor was returned to normal operation. (auth)

17549 SAFETY-RELATED OCCURRENCES REPORTED IN FEBRUARY AND MARCH 1973. Casto, W. R. (comp.) Nucl. Safety; 14: No. 4, 372-375(1973).

The Dow TRIGA was discovered to have gained reactivity while it was shut down and undergoing fuel inspection. Millstone Point had a minor problem with plating flaking from the inside of accumulator tanks. A relief valve, a main-steam-line isolation valve, and a condensate return valve failed during a scram at Oyster Creek. During the inspection and repair work, three mechanics were exposed to ^{133}Xe that drifted from the opened flanges. At Surry, the operation of Unit 1 caused contamination in the containment of Unit 2 through a common system. (auth)

17550 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Sheldon, M. (comp.) Nucl. Safety; 14: No. 4, 376-383(1973).

Reactor Theory and Calculation

Refer also to abstract 17367.

17551 (CONF-730803-2) EXPERIMENTAL DETERMINATION OF TURBULENT EXCHANGE COEFFICIENTS IN A MODEL REACTOR ROD BUNDLE. Roidt, M.; Vegter, B. J.; Pechersky, M. J.; Markley, R. A. (Westinghouse Research Labs., Pittsburgh, PA; Westinghouse Electric Corp., Madison, PA. Advanced Reactors Div.). 1973. Contract AT(11-1)-3045. 38p. Dep. NTIS $4.00.

A tracer gas is injected into a single subchannel of a large air flow model of a reactor rod bundle. The tracer fluxes are sampled at two positions downstream to obtain the axial variations in the fluxes through both the injection subchannel and those adjacent to it. Combining this information with measured subchannel area changes (which allow estimating the axial change in volumetric flow rates) yields measures of the turbulent eddy diffusion coefficient and subchannel cross flows. The results agree with other investigations. Turbulent exchange coefficients calculated from the data vary by ±50 percent, variations which should be expected when correlating exchange coefficients from experiments with different internal distributions of transportable scalar quantities. 11 references. (auth)

17552 (GKSS-73/E/6) GENDY: A GENERAL REACTOR DYNAMICS PROGRAM. Fiebig, R.; Krueger, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1973. 33p. Dep. NTIS (U. S. Sales Only) $3.75.

GENDY was made to solve a general system of up to 50 linear differential equations. The program is mainly meant to be a flexible instrument to solve arbitrary sets of geometrically independent reactor dynamics equations, which can suitably be formulated by the user. The method chosen for this purpose is a backward extrapolation technique. In order to have short computation times and uniform accuracy, a variable time step control was built in. For the case that non-linearity of the physical system is thought to be important for the accuracy of the solution, an iterative procedure is built in for optional use. (auth)

17553 (JAERI-M-4705) A FEW REMARKS FOR CALCULATIONS OF PROMPT NEUTRON DECAY CONSTANT AT DELAYED CRITICAL OF FAST REACTOR SYSTEMS. Nakano, M.; Hiracka, T. (Japan Atomic Energy Research Inst., Tokyo). Feb 1972. 12p. INIS.

It is clarified that inconsistent selection of the fission spectrum in the calculation of the prompt neutron decay constant at delayed critical, α_c, by the eigenvalue calculation leads to a difference in the value of α_c of more than 10%. Attention should be paid to the difference in the fission spectrum between the static calculation and the dynamic calculation. The difference of the prompt neutron decay constant between the eigenvalue calculation and the perturbation calculation is also investigated. At delayed critical, it is less than a few percent since the effect of the distortion is compensated by the effect of the difference in fission spectrum between the eigenvalue calculation and the perturbation calculation. However, the difference becomes large as the effective multiplication factor decreases. (auth)

17554 (JAERI-M-4760) SENSITIVITY COEFFICIENT OF INTEGRAL DATA AND GENERALIZED PERTURBATION METHOD. Mitani, H.; Kuroi, H. (Japan Atomic Energy Research Inst., Tokyo). Mar 1972. 39p. (In Japanese). NTIS (U. S. Sales Only).

A method is described of calculating sensitivity coefficients of the integral data used in the adjustment of group cross sections. A usual perturbation method can be used to calculate the change of an effective multiplication factor due to the change of various parameters in a system. To calculate the change of reaction rate ratios and sample worths in perturbed and unperturbed systems, however, a generalized perturbation method developed by Usachev and Gandini must be used. Numerical examples of sensitivity coefficients of the integral data used in the adjustment of group cross sections are given. (auth)

17555 (JAERI-M-5020) STUDIES ON THE METHODS OF COLLAPSING THE DIFFUSION COEFFICIENTS. Tasaka, K.; Seki, Y. (Japan Atomic Energy Research Inst., Tokyo). Oct 1972. 56p. (In Japanese). NTIS (U. S. Sales Only).

In nuclear design of a fast reactor, considerable time is required for the two-or three-dimensional calculations or burnup calculations based on the diffusion approximation. The few group reactor constants obtained by collapsing many-group reactor constants are usually used. The problem of collapsing the diffusion coefficient in collapsing multi-group reactor constants is considered. In order to examine the effect of collapsing and to simplify the analysis and also to eliminate ambiguity due to the arbitrary division of the collapsed energy groups, the number of collapsed energy groups is one. The one-dimensional spherical calculational models of fast reactor are the following two: a simple system consisting of core and blanket, and one composed of two-zone core, control region, and blanket. The effect of variation in the division of the system is also examined. (auth)

17556 (JAERI-M-5022) APPLICABILITY OF ONE-GROUP DIFFUSION THEORY FOR BURNUP ANALYSIS OF A FAST REACTOR. Yoshida, H.; Tasaka, K. (Japan Atomic Energy Research Inst., Tokyo). Oct 1972. 12p. NTIS (U. S. Sales Only).

The applicability of one-group diffusion theory for burnup analysis of a spherical fast reactor with a core volume of 3700 liters was compared with multi-group diffusion theory in the variation of effective multiplication factor, power distribution, and atom densities. The following were revealed: (1) The variations of power distribution and atom densities can be estimated with good accuracy with one-group reactor constants of the initial state; and (2) The variation of effective multiplication factor can be inferred accurately with one-group reactor constants based on the perturbation theory even when the spectrum change of the reactor core is not taken into consideration. Burnup characteristics of fast reactors can thus be estimated fairly accurately by the burnup analysis based on one-group reactor constants of the initial state. An approximate method developed for representing the burnup-dependent one-group reactor constants is also described and the results of calculations are presented. (auth)

17557 (JAERI-M-5076) STUDY OF THE PERTURBATION METHODS USED IN FAST REACTOR ANALYSIS. Seki, Y.

(Japan Atomic Energy Research Inst., Tokyo). Dec 1972. 37p. (In Japanese). NTIS (U. S. Sales Only).

The role of perturbation methods in fast reactor analysis is thoroughly investigated. The ambiguity in the accuracy of the perturbation method is the main limitation in the applicability of the method. The reactivity changes caused by the insertion of various kinds of core materials into a typical fast reactor in various manners are calculated by the direct method, an exact perturbation formula, and the first and second order perturbation methods. The results indicate the following: (1) There is a systematic difference between the values of reactivity change obtained by the direct calculation and by the exact perturbation formula; (2) As an exact calculation method of reactivity change, the exact perturbation formula is recommended rather than the direct method because the latter is too sensitive to the conditions imposed on the numerical calculation; (3) The applicability criterion of the first order perturbation method can be determined for a typical fast reactor; (4) The second order perturbation method based on the generalized perturbation method is effective in improving the accuracy of the first order perturbation method by a factor of 10, for the case where the neutron flux change caused by the perturbation is smaller than the unperturbed neutron flux; and (5) For accurate and simple calculations of reactivity changes, the exact perturbation formula with the real and adjoint neutron fluxes obtained under relaxed convergence criteria is appropriate. (auth)

17558 (MRR-103) NODAL APPROXIMATIONS FOR THE CALCULATION OF NEUTRON FLUX DISTRIBUTIONS IN LARGE LIGHT WATER REACTORS. Maurer, W. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Mar 1972. 49p. (In German). INIS.

A survey is presented of nodal approximations for calculating neutron flux distributions in large light water reactors, with emphasis on the problem of the inter-node leakage. The gross-coupling and D_{eff}/L methods are outlined as well as the fusion source method used in FLARE. Furthermore, several new nodal methods are presented with improved models for describing the coupling of adjacent nodes. (GE)

17559 (N-73-14709) MULTIDIMENSIONAL ANALYSIS OF FAST SPECTRUM MATERIAL REPLACEMENT MEASUREMENTS FOR SYSTEMATIC ESTIMATION OF CROSS SECTION UNCERTAINTIES. Klann, P. G.; Lantz, E.; Mayo, W. T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1973. 36p. (NASA-TM-X-2679; E-7069). NTIS.

A series of central core and core-reflector interface sample replacement experiments for 16 materials performed in the NASA heavy-metal-reflected, fast spectrum critical assembly (NCA) were analyzed in four and 13 groups using the GAM 2 cross-section set. The individual worths obtained by TDSN and DOT multidimensional transport theory calculations showed significant differences from the experimental results. These were attributed to cross-section uncertainties in the GAM 2 cross sections. Simultaneous analysis of the measured and calculated sample worths permitted separation of the worths into capture and scattering components which systematically provided fast spectrum averaged correction factors to the magnitudes of the GAM 2 absorption and scattering cross sections. Several Los Alamos clean critical assemblies containing Dy, Ta, and Mo as well as one of the NCA compositions were reanalyzed using the corrected cross sections. In all cases the eigenvalues were significantly improved and were recomputed to within 1 percent of the experimental eigenvalue. A comparable procedure may be used for ENDF cross sections when these are available. (auth)

17560 (RT/FI-(72)47) ELEMENTS OF FAST REACTOR PHYSICS AND CALCULATION. Gandini, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 31 Oct 1972. 312p. (In Italian). Dep. NTIS (U. S. Sales Only) $17.75.

A manual on fast reactor physics and calculations based on a series of lectures given to students with a basic knowledge of reactor physics is presented. The topics considered are various types of fast reactors, neutron calculations, multigroup constants, approximation of the Boltzmann equation, kinetics, generalized perturbation methods, effects of heterogeneity, analysis of reactivity effects, and the Doppler effect. (18 references) (JSR)

17561 AXIAL AND TRANSVERSE MOMENTUM BALANCE IN SUBCHANNEL ANALYSIS. Rouhani, Z. (Aktiebolaget Atomenergi, Studsvik, Sweden). (1973). vp.

From topical meeting on requirements and status of the prediction of physics parameters for thermal and fast power reactors; Juelich, Germany (23 Jan 1973).

A subchannel is defined as the flow area between adjacent rods or other solid walls. For the case of single-phase flow, proper relationships and coefficients for the exchange of momentum between subchannel equations are set up. (GE)

17562 HIGHER ORDER PERTURBATION METHOD IN REACTOR CALCULATIONS. Mitani, H. (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng.; 51: No. 2, 180-188(Jun 1973).

A higher order perturbation formula for calculating changes in the reactivity up to a desired order in concise form is given; the formula uses the iterative technique well known in quantum mechanics and in the neutron life-cycle method. This procedure is possible only when the adjoint flux in the unperturbed system is used as the weighting function. The higher order perturbation formula contains the interaction between the perturbation inserted and its surrounding medium, but it consists only of the integration over the perturbed region. Numerical calculations up to the third-order perturbation show that the first-order perturbation technique gives a low value for the reactivity worths of fission, absorption, and scattering materials; further, the n'th-order perturbation is proportional to the n'th power of the concentration of an inserted perturbation. (auth)

17563 ONE-SPEED NEUTRON TRANSPORT PROBLEMS. Part II. Slab Transmission and Reflection and Finite Reflector Critical Problems. Caroll, G.; Aronson, R. (New York Univ., Bronx). Nucl. Sci. Eng.; 51: No. 2, 166-179(Jun 1973).

The double-P_N approximation for azimuthally symmetric situations is described. Explicit representations for basic matrices are derived. The transfer matrix equations were solved on the CDC-6600. Results are presented for two problems of interest-transmission and reflection from thick slabs and the finite reflector critical problem. Anisotropic scattering is considered in both cases. Tables of typical computing times are presented. (auth)

17564 ONE-SPEED NEUTRON TRANSPORT PROBLEMS. Part I. Exact Transfer Matrix Formulation. Aronson, R. (New York Univ., Bronx). Nucl. Sci. Eng.; 51: No. 2, 157-165(Jun 1973).

The transfer matrix formulation of exact one-speed neutron transport with isotropic scattering in slab geometry is extended to arbitrary anisotropic scattering and to azimuthally dependent problems. Explicit comparison is made with results obtained by Case's method, and some new relations expressing reciprocity are derived. The special case of no absorption is considered separately. (auth)

17565 SOLUTION OF THE SPACE-DEPENDENT REACTOR KINETICS EQUATIONS IN THREE DIMENSIONS. Ferguson, D. R.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 51: No. 2, 189-205(Jun 1973).

A general class of two-step alternating-direction semi-implicit methods is proposed for the approximate solution of the semi-discrete form of the space-dependent reactor kinetics equations. An exponential transformation of the semidiscrete equations is described which has been found to significantly reduce the truncation error when several alternating-direction semi-implicit methods are applied to the transformed equations. A subset of this class is shown to be a consistent approximation to the differential equations and to be numerically stable. Specific members of this subset are compared by considering two-dimensional numerical experiments. An "optimum" method, termed the non-symmetric alternating-direction explicit method, is extended to three-dimensional geometries. Subsequent three-dimensional numerical experiments confirm the truncation error, accuracy, and stability properties of this method. (auth)

17566 EVALUATION OF THE SECOND-ORDER PERTURBATION TERMS BY THE GENERALIZED METHOD. Seki, Y. (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng.; 51: No. 2, 243-251(Jun 1973).

The perturbation formula introduced by Gandini for calculation of a nuclear reactivity change in second-order accuracy is modified to permit its wide applicability. It is shown that the formula could give the second-order perturbation terms for the respective reaction components. Application of the formula and its calculation method are described. (auth)

17567 NEW METHOD OF SOLVING THE MULTIMODE REACTOR KINETICS EQUATIONS. Turnage, J. C. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 51: No. 1, 67-76(May 1973).

An investigation is made of a new approach to solving the multimode kinetics equations. These equations are cast into a matrix generalization, $(d/dt)[\Psi] = [A][\Psi]$, of the point kinetics equations and successfully solved by applying an analytic inversion of the matrix $[[I] - \epsilon[A]]$ to both the Padé (2,0) and modified Padé (1,1) approximations to $\exp(\Delta t[A])$. (auth)

17568 GREEN'S FUNCTION FOR A COMPOSITE SEMI-INFINITE SLAB. Rogers, G. J. (Univ. of Southampton, Eng.); Fox, P. F. J. Phys., D (London); 6: No. 6, 651-656(9 Apr 1973).

A Green's function for a composite semi-infinite heat conducting slab or its electrostatic analogue is developed as it arises in the study of nuclear reactor performance. The solution is derived by a transformation technique. (auth)

17569 FAST REACTOR DESIGN OPTIMIZATION SYSTEM WITH A METHOD OF NONLINEAR PROGRAMMING. Inoue, K. (Hitachi, Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 51: No. 1, 1-9 (May 1973).

A design optimization system for a fast reactor is discussed. The system consists of a nonlinear programming code and the usual design codes. If proper design criteria and an initial estimate of a design point are provided, the optimum design point, subject to those criteria, can be automatically obtained by the system which was successfully applied to the optimization and sensitivity analysis of a typical large fast reactor. The results show both the features of the optimized reactor and the effects of variations in the main design criteria on the design. (auth)

17570 REACTOR NEUTRON SPECTRA IN A CYLINDRICAL NEUTRON DUCT SURROUNDED BY WATER. Bass, L. P.; Broder, D. L.; Zhilkin, A. S.; Kutuzov, A. A.; Smetanin, A. A.; Suvorov, A. P.; Shestopalov, E. V.; Shiplov, A. E. Vop. Fiz. Zashch. Reaktorov; No. 5, 123-129(1972). (In Russian).

The energy and spatial distributions of neutrons with energies above 200 keV in an iron cylindrical neutron duct at distances up to 66 cm from the origin of neutrons are discussed. The experimental data are compared with computational results made by two-dimensional programs using the P_1-approximation of the spherical harmonics method and the $2D_{10\times5}$-approximation of the characteristic method. The presence of experimental data on the neutron energy spectra makes possible a corrective check on the methods for calculating the parameters of shields of limited transverse dimensions. (JPRS)

17571 ORTHOGONAL PROJECTION METHOD FOR THE NUMERICAL SOLUTION OF A FIELD PROBLEM. Rafalski, P. (Inst. of Nuclear Research, Warsaw). Int. J. Numer. Methods Eng.; 6: No. 2, 287-296(1973).

A numerical method, based on the orthogonal projection method of Hilbert space, is given. Two approximate solutions, which bound the exact solution from above and below, are described. The error of the approximate solution is calculated directly. An example of a calculation of temperature field in a nuclear reactor shell is presented. (auth)

17572 THEORY OF STOCHASTIC FLUCTUATIONS IN A POWER REACTOR. Morishima, N. (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 10: No. 1, 29-44(Jan 1973).

A theoretical study is made on stochastic fluctuations in power reactors. The theory is demonstrated by treating a specific but widely existing example of a liquid-cooled and -moderated reactor operated with either natural convection or forced circulation. Attention is first directed to the thermodynamical analysis of the elementary transport processes of the energy released by fissions through the fuel and coolant. A set of equations for the lumped reactor system are derived for the state variables, i.e., coolant flow-rate, coolant temperature and fuel temperature. A noise source bringing about fluctuations of the coolant flow-rate is assumed to be the most influential among all the noise sources. This idea is taken into the stochastic model by using the Langevin method. As a result of this treatment, a stochastic description is given for the transport processes of nuclear, thermal, and hydraulic quantities by deriving the Markoffian master equation and subsequently the moment equations. The theory is examined by reference to the neutron noise spectrum for the two kinds of the coolant flow pattern. It is shown that the theory can describe quantitatively, at least in part, the actual observed noises, in particular the anomalous growth of neutron noise spectra at lower frequencies. (auth)

17573 EFFECT OF GROUP COLLAPSING IN PERTURBATION THEORY FOR SAMPLE WORTH ANALYSIS. Kuroi, H.; Mitani, H.; Hirota, J. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 10: No. 3, 139-145(Mar 1973).

The effect of group collapsing applied to the perturbation theory for sample worth analysis in fast reactor systems is theoretically and numerically examined assuming the validity of the thin sample approximation. As a result, the calculated worths of scattering materials placed at the center of the core are found to be strongly influenced by the group collapsing. The effect on the sample worth when the sample is placed in positions off the core center decreases with increasing distance from the center. It is noted that the reactivity perturbation due to inelastic scattering is also affected significantly by group collapsing especially near the core-blanket interface. Based on the above observations, it is concluded that the perturbation theory with about 70 energy groups appropriately arranged is necessary to reproduce the experimental values of Na, O and Fe sample reactivity worths with accuracy efficient for ordinary purposes. (auth)

Reactor Components and Accessories

Refer also to abstracts 15947, 15948, 15966, 15986, 15995, 16009, 16049, 16091, 16098–16103, 16115, 17467, and 17570.

17574 (LFEN-146-a) SYSTEM FOR ACQUISITION OF DATA FOR ANALYSIS OF NOISE. Costa Oliveira, J. M.; Trigueiros, D. F.; Pombo Duarte, J. M. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1972. 33p. (In Portuguese). Dep. NTIS (U. S. Sales Only) $3.75.

The experimental study of dynamic phenomena can be made digitally in two phases: (1) recording of data in magnetic memory and then digitalization; (2) processing of the data in the computer. A system of data acquisition is characterized. It is essentially for the analysis of noise in the reactor. This system allows the simultaneous study of four analysis methods and includes a transmission channel with a line of 300 m, which allows the data to be sent to a computer installed in another building. (tr-auth)

17575 (RDT-E-4-2-T(6-73)) HEAT EXCHANGER, CLASS 1, WATER-TO-WATER, STRAIGHT OR U-TUBE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 18 Jun 1973. 27p. RSO.

A standard is presented which covers construction and acceptance of water-to-water, reactor coolant shell and tube heat exchangers meeting the Class 1 requirements of the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components. The standard includes U-tube, straight tube, and special configuration types of heat exchangers. (auth)

17576 (RDT-E-6-38-T(5-73)) LOW FRICTION HARD SURFACES FOR CORE COMPONENTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1973. 15p. RSO.

A standard is presented which sets forth the requirements for the formulation, application, quality assurance, packaging, and delivery of low friction hard surfaces on finished or semifinished core components to be used in liquid metal cooled reactors. The requirements for a specific hard surfacing on a given core component or group of components are established. The purpose of hard surfaces is to provide low friction between contacting components that must maintain a capacity for relative motion in a liquid metal environment. Low friction, non-seizing, and anti-galling properties must be maintained over a range of environmental conditions covering reactor startup, refueling, and operation. (auth)

17577 (RISO-277) ACOUSTIC EMISSION SURVEILLANCE METHODS. Nielsen, A. (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec 1972. 28p. Dep. NTIS (U.S. Sales Only) $3.50.

The status of the acoustic emission technique with respect to its application during proof testing, recurrent testing, and service of steel pressure vessels for nuclear plants is discussed. During proof testing it is evident that the location of acoustic emission sources can be carried out very reliably. The problem of warning against catastrophic failure cannot at present be given a clear answer, although an experienced operator can make an approach to the problem and very promising investigations are in progress. During recurrent inspection it should be possible to gain further information on the state of the steel structure by applying the acoustic emission technique if the structure is accessible. Not much experience has been gained of acoustic emission surveillance during service in terms of signature analysis, but very promising investigations are in progress to solve the various problems by using the acoustic emission technique in the hostile environment of a nuclear reactor. (auth)

17578 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR POWER PLANT. Worley, N. G. (to Babcock and Wilcox Ltd.). British Patent 1,312,457. 4 Apr 1973. Filed date 13 May 1970. 3p.

The heat exchanger described includes tubes with lengths that are aligned in rows, some of the tube lengths being included in one group of circuits and some in a second group of circuits. The tube lengths are supported by support members extending transversely of the row, and each group is freely transversible by members of the other group. (UK)

17579 PRESTRESSED CONCRETE PRESSURE VESSELS. Tanak, K. (Electric Power Development Co. Ltd., Tokyo). Konkurito Janaru; 10: No. 6, 72-78(Jun 1972). (In Japanese).

The present status of the application of PCPVs to atomic power plants is explained. It includes: a list of power reactors which use the PCPVs; design criteria and method of stress analysis; component materials for the PCPVs such as concrete, materials for liners and penetrating holes, thermal insulator and coolant, and the method of winding and fixing steel wires. Future trends of PCPV research and development are discussed. Developmental problems of the PCPVs are briefly explained in regard to the development of HTGRs. Problems of safety evaluation of the PCPVs are also discussed in comparison with the pressure vessels of light water reactors. (JA)

17580 SHUT-OFF AND CONTROL VALVE FOR LIQUID METAL LOOPS. Niederstetter, H. (to Interatom Internationale Atomreaktorbau GmbH). German Patent 1,813,137. 18 Jun 1970. Filed date 6 Dec 1968. 12p. (In German).

A shut-off and control valve for liquid metal circuits with large diameters, such as reactor coolant circuits with liquid sodium, is described. The valve is characterized by a rotational-symmetrical pressure vessel with an upper plate for the control elements and an under plate for the axial guide bearing and with an inlet and outlet plate. A rotating movable sleeve is placed on the upper plate. A lifting mechanism discharges into the sleeve. (JSR)

17581 SUPPORTING DEVICE FOR TUBULAR ARRAYS HELICALLY WOUND TO FORM SEVERAL COAXIAL CYLINDRICAL LAYERS. (to Societe Babcock-Atlantique). French Patent 2,121,348. 25 Aug 1972. Filed date 5 Jan 1971. 15p. (In French).

A description is given of a system of helically wound tubular arrays presenting several diameters in relation to the neutral axis about which they are wound, tubes of the same diameter forming a cylindrical layer, the various coaxial layers being positioned one inside the other. This sort of tubular array is particularly useful for liquid sodium reheated steam generators. The winding axis is vertical and the tubular array is provided with an annular space defined by two coaxial skirtings. The supporting assembly and spacer system developed for the helicoidal tubes are also presented. (FR)

17582 NUCLEAR REACTOR LOOP REACTIVATION SYSTEM. Brown, W. W.; Loose, R. A.; Vogel, J. A. (to Westinghouse Electric Corp.). U. S. Patent 3,734,823. 22 May 1973. Filed date 18 Nov 1969. 4p.

A means for protecting a nuclear reactor against rapid insertion of reactivity upon the reactivation of an isolated hoop is described. A temperature interlock, a flow mixing line and a time sequence logic system are coupled to each loop of a nuclear reactor to insure that the temperature and boron concentration of the fluid in each loop are acceptable before such a loop can be recoupled to the reactor coolant system. (Official Gazette)

17583 INSTALLATION FOR VAPOR PRODUCTION FOR A NUCLEAR REACTOR. Vollhardt, F.; Rheinlaender, P. (to Siegener AG). German Patent 1,922,646. 11 Feb 1971. Filed date 3 May 1969. (In German).

An installation for the production of steam for a liquid metal cooled nuclear reactor uses an inert gas to transfer the heat from the liquid metal to the heating surfaces of the steam generator. A supplementary metal bath is provided so that the heating surfaces of the steam generator are not in contact with the inert gas led into the circuit. (TSS)

17584 IMPROVEMENTS IN METHODS OF TESTING FOR FUEL ELEMENT SHEATHING FAILURES. Boorman, C.; Collinson, A. E. (to United Kingdom Atomic Energy Authority). British Patent 1,305,903. 7 Feb 1973. Filed date 10 Apr 1969. 4p.

Reference is made to methods for testing for fuel element sheathing failures in liquid cooled nuclear reactors by detecting gas escape from the fuel elements into the coolant. In the system described means are provided to cause the coolant to spin and cause any gas to be directed towards and collect in zones at the center of the flow paths. These zones are scanned by ultrasonic scanners, and means are provided to measure the angular displacement of the scanners where a zone containing gas is detected. The means for causing the coolant to spin comprise sets of vanes downstream of the fuel elements, creating gas collection zones in the liquid coolant above the core structure. (UK)

17585 SAMPLING SELECTOR FOR LOCALIZING BURST SLUGS. Debergh, P.; Lagrange, M. (to Commissariat a l'Energie Atomique). French Patent 2,128,167. 20 Oct 1972. Filed date 9 Mar 1971. 9p. (In French).

A sampling selector for the exact direct localization of burst slugs in a fuel assembly is described. The sampling tubes are fixed in a distribution plate and connected to extensions of the canals containing the fuel assemblies in order to allow the passage of the fluid coolant circulating in these canals in the direction of an analysis apparatus. Each of the tubes corresponds to one of the canals or fuel assemblies. Means are provided for rotating the table and displacing the fluid-sampling tube above the tubes in a succession of hypocycloids. (FR)

17586 OPERATIONAL EXPERIENCE WITH VALVES IN NUCLEAR POWER STATIONS. Arriens, K. H. (VGB Technische Vereinigung der Grosskraftwerksbetreiber eV, Essen). VGB Kraftwerkstechnik; 53: No. 2, 82-87(1973). (In German).

From VGB special meeting; Linz, Austria (14 Sep 1972).

The slightest leakage in valves in nuclear power stations can lead to considerable operational restrictions. A solution to this problem has been discussed between manufacturers and operators in the VGB Specialist Committee on Pipework and Valves. Results are discussed. (GE)

17587 SHIELDING ELEMENTS FOR NUCLEAR REACTORS. Stahlschmidt, H.; Aisch, D.; Kuster, H. (to Siemens AG). German Patent 1,933,750. 14 Jan 1971. Filed date 3 Jul 1969. (In German).

Shielding elements, particularly for filling openings and holes in the walls and shielding of reactor containment vessels, are characterized by the fact that the shielding elements are arranged in the fashion of pressure plates with prismatic sections and presenting an outer layer with a stable form thus maintaining at least the equilibrium with the interior structure on a sand base. (TSS)

17588 CURRENT STATE OF METHODS FOR CALCULATING PARAMETERS OF RADIATION SHIELDING OF REACTORS. Orlov, V. V.; Suvorov, A. P. Vop. Fiz. Zashch. Reaktorov; No. 5, 7-21(1972). (In Russian).

Problems which must be solved in the process of designing a reactor shield have been determined. Among these are the passage of radiation in media with a one-dimensional geometry, the passage of radiation in media with two- and three-dimensional geometries, consideration of multidimensional heterogeneities, the distribution of radiation in media with cavities, reflection of radiation from the media, the angular distribution of radiation coming from the shield, and optimization of the shield design using modern mathematical methods and computers. Each of these problems requires the development of special computational methods and the development of special computer programs to a greater or lesser degree. (JPRS)

17589 REACTOR SAFETY VESSEL. Stein, R. (to Paul Hammers AG). German Patent 1,684,718. 15 Apr 1971. Filed date 20 Jun 1967. (In German).

A reactor safety vessel made of reinforced concrete is characterized by the fact that the vessel is composed of separate elements that have been prefabricated and can be interlocked with each other along the lines of articulation. (TSS)

17590 ELECTROHYDRAULIC CONTROL SYSTEM FOR NUCLEAR STEAM TURBINE. Sakamoto, T.; Torii, A.; Yokota, M. (Tokyo Shibaura Electric Co. Ltd., Kawakaki, Japan). Toshiba Rebyu; 28: No. 2, 184-191(Feb 1973). (In Japanese).

Many problems peculiar to nuclear steam turbine control systems are solved by the electrohydraulic control system (EHC) newly developed. Details of the EHC for large nuclear steam turbines are introduced. To qualify the reliability of the EHC system, a special room has been prepared in the factory for tests and adjustment of EHC Units. (auth)

17591 IN-SERVICE INSPECTION OF REACTOR PRESSURE VESSELS. Rath, W. (Krautkramer, GmbH, Cologne). Power Eng.; 77: No. 7, 40-43(Jul 1973).

Requirements for the inspection of reactor pressure vessels in the German Federal Republic are described. The general features of the ultrasonic equipment used are summarized. Some experiences and costs at operating power reactors are discussed. (JWR)

Reactor Fuels

Refer also to abstracts 15445, 15844, 15845, 15847, 15861, 15864, 15866, 15869, 15874–15876, 15906, 15923, 15934, 15945, 15953, 16006, 16043, 16098, 16104, 16153, and 16979.

17592 (CEA-R-4432) THEORETICAL MODEL OF THERMAL INTERACTION BETWEEN URANIUM DIOXIDE AND SODIUM. Syrmalenios, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1973. 43p. (In French). Dep. NTIS (U.S. Sales Only) $4.25.

The present theoretical model predicts the time history of temperatures, pressure, vapor volume and interaction zone expansion velocity during uranium dioxide–sodium thermal interactions. Principal assumptions of the model are: a time process for uranium dioxide fragmentation is taken into account and fuel fragments which can be considered as spherical are divided into two groups. The first group contains only large fuel particles that are fragmented by time steps. The second group contains fuel particle families. Each family contains only small fuel particles and is born from the first group at each fragmentation time step. The heat transfer rate from the fuel to the coolant is calculated with a given heat transfer coefficient. The large particle group's temperature is taken to be uniform as well as each small particle family's temperature. When a family is born its temperature is equal to the big particle group's temperature. Heat is transfered from the uranium dioxide only to the liquid sodium, while the presence of sodium vapor reduces the heat transfer rate. The liquid–vapor sodium phases are not in thermodynamic equilibrium. The interacting sodium mass (hot sodium) varies according to a law that takes into account conduction and convection heat transfer from the hot sodium to the noninteracting sodium (cold sodium). The physical state of the interacting liquid sodium is given by thermodynamic relations for compressible fluids. The noninteracting liquid sodium is taken as incompressible in calculations for the channel voiding rate. These calculations are made in one dimensional cylindrical geometry. With these assumptions energy, mass and momentum equations are written for the system. The resulting mathematical model is formed by 8 + i differential equations with 8 + i unknowns where i is the number of small fuel particle families. The computer code CORFOU uses a KUTTA-MERSON method to resolve these differential equations. This model has been applied to some particular examples. (auth)

17593 FUEL ELEMENT FOR NUCLEAR REACTORS. Juric, S. (to Licentia Patent–Verwaltungs GmbH). German Patent 1,614,082. 26 Feb 1970. Filed date 22 Aug 1967. 14p. (In German).

A fuel element with coated particles and a heat conductor is described. The heat conductor forms, with respect to the fuel jacket, a special construction element which forms a large number of contact surfaces with the jacket. The heat conductor has spiral coolant channels separated from each other and fins fixed to the fuel jacket and is formed of rectangular tubes centrally surrounding the fuel element. The heat conductor of the hollow cylindrical fuel element serves as an internal reinforcement of the fuel element and/or for coolant removal and is hollow with a star-shaped cross section, the points of which are connected to the jacket. It is fixed only to the hot spots of the fuel element and has support fins within and/or outside of the fuel element. The heat conductors which are controls for the current cross section of the coolant flow are constructed of graphite or ceramic material. (JSR)

17594 END SEAL FOR A TUBULAR REACTOR FUEL ELEMENT. Beckmann, G. (to Licentia Patent–Verwaltungs GmbH). German Patent 1,564,274. 22 Jan 1970. Filed date 29 Aug 1966. 7p. (In German).

The end seal for a tubular fuel element is described. The external and internal tubes of the fuel element consist of different materials and the end seal consists of two different materials. The materials of the external ring and the external tube and the materials of the internal ring and the internal tubes are either the same or are weldable to each other. Parts of the end seal are placed elastically into each other. The elastic link is formed by two gasket rings arranged over each other. Each ring is capable of taking over the complete sealing separately. (JSR)

17595 SPACER CONTAINER FOR FUEL ELEMENTS OF WATER-COOLED REACTORS. Christ, R.; Christiansen, U. (to Nukem Nuklear-Chemie und Metallurgie GmbH). German Patent 1,564,430. 12 Feb 1970. Filed date 16 Aug 1966. 5p. (In German).

A spacer container for fuel elements of water-cooled reactors with a number of fuel rods in quadratic arrangement is described. The container consists of a web lattice provided with springs. The springs are built as spring U bolts. The U bolts hang in the web lattice serving as bearing supports but are not rigidly connected to it. The web lattice consists of a material with low absorption cross section for neutrons, preferably zirconium or a zirconium alloy, and the spring U bolt is made of heat-resistant iron or nickel alloy. (JSR)

17596 SPACER CONTAINER FOR FUEL ELEMENTS WITH A NUMBER OF FUEL RODS. Christ, R.; Christiansen, U. (to Nukem Nuklear-Chemie und-Metallurgie GmbH). German Patent 1,564,434. 22 Jan 1970. Filed date 25 Aug 1966. 8p. (In German).

A spacer container for fuel elements, with a number of fuel rods in a quadratic arrangement, is described. It consists of pipe sections connected by cross pieces which are arranged between every four neighboring fuel rods. The pipe sections have an essentially square cross section and are provided with flexible springs on the side. The springs are punched or stamped from the sides of the pipe sections. The square pipe sections at both ends in the extensions of the sides are provided with four trapezoid flexible springs. Square pipe sections with springs alternating in the crosspiece arm and square pipe sections with relatively rigid stops in the form of cams are so arranged that each fuel element is squeezed by two springs perpendicular to each other against two cams. (JSR)

17597 END SEAL OF ZIRCONIUM-CLAD REACTOR FUEL RODS. Koehler, L.; Stehle, H. (to Siemens AG). German Patent 1,564,632. 22 Jan 1970. Filed date 18 Jun 1966. 10p. (In German).

The end seal of zirconium-clad reactor fuel element rods with welded end caps is described. In addition to the weld seam washer, a mechanical auxiliary seal coolable during the welding is provided opposite the fuel rod interior. The end cap has, at the weld, a short seat for the fuel rod clad and is provided at its end with a ring-shaped sealing beam. The auxiliary seal is formed of a compressed jacket sealed at one side with a metallic gasket of, for example, silver. The auxiliary seal can be formed of a cone compressed on an inner edge of the jacket. The auxiliary seal can also be formed by plastic deformation of the jacket in a ring depression. For cooling the auxiliary seal during the welding, radiators of high heat conductivity are provided. (JSR)

17598 DEVICE FOR THE WINDING OF WIRES ON NUCLEAR REACTOR FUEL RODS. Kresslein, H. (to Licentia Patent Verwaltungs GmbH). German Patent 1,614,113. 27 May 1970. Filed date 28 Dec 1967. 10p. (In German).

A device for winding wires on reactor fuel rods, in which the fuel rod is rotated spirally against the wire, is described. A mobile sleeve is arranged coaxially around a stationary groover having a spiral groove. A guide pin leading into the spiral groove is present in the sleeve. The fuel rod to be wound is mounted on the sleeve and a female piece for wire-rod guide on the groover. The groover is a thick-walled tube within which a solid supporting tube of concentric cable, which can be coupled to the sleeve, slides. The supporting tube can be coupled with the fuel rod to be wound. A female piece with wire-rod guide is placed on the groover and the supporting tube is passed through the female piece at the end. The female piece has in the wire-rod guide a spring-loaded pin for extrusion of the wire. The support tube is solidly coupled by means of a pin with the sleeve. The support tube is connected on the drive side of the device with a rotary switch. (JSR)

17599 NUCLEAR REACTOR FUEL ELEMENT BUNDLE. Ritz, L. (to Gesellschaft fuer Kernforschung mbH). German Patent 1,589,807. 11 Jun 1970. Filed date 23 Feb 1967. 6p. (In German).

A reactor fuel element bundle consisting of several individual fuel elements arranged side by side with cooling fins running in a helix is described. The fuel bundle has slit-like apertures at given intervals. The slits with the radius of the individual fuel elements enclose an angle of <90°, preferably an angle between 35° and 55°. The front edge of the slits forms, with the primary current flow of the coolant, almost a right angle. The slits are as large as the neighboring fins with the radius of the pertinent individual elements and enclose angles opposed to each other. (JSR)

17600 FUEL ELEMENT FOR NUCLEAR REACTORS. Dahlgren, T.; Hakansson, U.; Ljungh, T. (to Aktiebolaget Atomenergi). German Patent 1,589,482. 9 Apr 1970. Filed date 23 Nov 1967. 15p. (In German).

A fuel element for a reactor with a number of fuel rods arranged parallel to each other, with at least one spacer container which keeps the fuel rods at the desired distance from each other and with a support container which keeps the spacer in the axial direction of the fuel rods, is described. The support container consists of banking faces provided on at least one of the fuel rods. The banking face is geared to the spacer container. The banking faces consist of annular grooves of the respective fuel rods. At least one of the fuel rods is split at the place where it passes through the spacer container. The spacer container projects at least one tab at the spacing site between the ends of the fuel rods. The tabs are at an angle to the normal plane of the fuel rod axis. (JSR)

17601 SEALING END FOR A REACTOR FUEL ELEMENT. Francke, K. P.; Zutz, L. (to Licentia Patent–Verwaltungs

GmbH). German Patent 1,614,053. 27 May 1970. Filed date 18 Apr 1967. 10p. (In German).

A jacket end seal for reactor fuel is described. The end plug has a tubular extension whose ends are connected with the jacket. The bending resistance of this extension is of the same order of magnitude as the bending resistance of the jacket. The fuel elements form a hollow cylinder with the jacket and the end plugs for each jacket have a tubular extension. The connection sites between the end plugs and the jackets of the fuel elements are formed as butt-welded seams. Only one end plug has a tubular extension. The tubular extension has lugs which are fused in a butt welding. (JSR)

17602 NUCLEAR REACTOR FUEL ELEMENT SPACER ASSEMBLY LOCK. Nakazato, S. (to Continental Oil Co.). U. S. Patent 3,736,227. 29 May 1973. Filed date 1 Jun 1970. 6p.

A nuclear reactor fuel element spacer arrangement has a fuel element supporting and spacing means through which respective fuel rods extend and which permits axial movement of the individual fuel rods while restraining them against lateral movement. In order to restrict axial movement of the spacer with respect to the entire assembly of rods, the fuel rod spacer is fastened to one of the fuel rods by a spring-loaded snap-in locking device. This prevents the fuel rod spacer distance along the fuel rods from being shifted as, for example, from fuel rod vibration or coolant drag force on the spacer or as a result of channel placement during installation. (Official Gazette)

17603 HOLD-DOWN ARRANGEMENT FOR NUCLEAR REACTOR FUEL SUBASSEMBLIES. Sakurama, N. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,736,226. 29 May 1973. Filed date 6 Nov 1970. 6p.

A method is described for retaining a nuclear fuel subassembly in position by using hydraulic pressure. The support divides the reactor vessel into four plenums by means of three support plates disposed one above the other. The fuel subassemblies are mounted on the top support plate and have portions which project through the second plate and are exposed to the pressure conditions of the lower medial plenum. The upper plenum is connected with the lower medial plenum at substantially the same relatively low pressure while the lower plenum and the upper medial plenum are connected to maintain them both at substantially the same relatively high pressure. Inlets for the fuel subassemblies are disposed in the upper medial plenum and outlets from the fuel subassemblies are in the upper plenum. (Official Gazette)

17604 NUCLEAR FUEL ASSEMBLY. Georges, N. J.; Pennell, W. E. (to Washington Electric Corp.). U. S. Patent 3,733,252. 15 May 1973. Filed date 26 Nov 1968. 8p.

A fuel assembly for nuclear reactors is described wherein grid members having openings in which a plurality of fuel rods are laterally supported and structurally integrated by temperature compensated longitudinal members of an elongated framing means to minimize thermal bowing of the fuel rods. (Official Gazette)

17605 PROCEDURE AND DEVICE FOR INCREASING THE PLASTICITY OF NUCLEAR FUELS WITH HIGH THERMAL CONDUCTIVITY BY INCREASE OF THE TEMPERATURE. Borkowetz, W. German Patent 1,963,139. 24 Jun 1971. Filed date 17 Dec 1969. (In German).

The operating temperature in the fuel during startup is maintained at a certain level thanks to the guarantee of a minimum resistance to heat transfer between the fuel and its can removed from heat, a level that produces a sufficient plasticity in the fuel. (TSS)

17606 DEVICE FOR THE SHEATHING OF FUEL ELEMENTS AND/OR FERTILE FUELS CONTAINING THORIUM. Muller, F.; Krahe, J. (to Kernforschungsanlage Juelich GmbH). German Patent 1,942,948. 19 May 1971. Filed date 23 Aug 1969. (In German).

A device is described for sheathing fuel and/or fertile elements, particularly fuel and/or fertile elements in which the fuel or fertile material is present in the form of particles covered with silicon embedded in a graphite matrix. A fluid bed is provided with a collecting base and condensers connected to the mobile layer that is characterized by the fact that the fluid bed is composed of graphite or another material known to be resistant to temperatures above 1000°C on which is supported a cladding of pyrolytic carbon. The exterior wall of the mobile layer of the fluid bed is brought to bear on a thin layer of titanium-containing silicon or of silicon carbide. (TSS)

17607 SPACER SUPPORT FOR FUEL ELEMENTS IN WATER-COOLED NUCLEAR REACTORS. Steven, J. (to Siemens AG). German Patent 1,764,046. 15 Apr 1971. Filed date 26 Mar 1968. (In German).

The support consists of a network of metal bands placed on edge in each opening in which a fuel rod is inserted by means of rigid bonds of the same composition as the material of the bands as well as the springs of another material, for example, of a chromium–nickel alloy, that is characterized by the fact that the spring pieces are in the form of bands that have their two extremities lying flat on the bands and are pressed onto them by curving through 180° and are welded between them. (TSS)

17608 PROTECTIVE DEVICE FOR FUEL ELEMENTS IN NUCLEAR REACTORS. Schweickert, H.; Stehle, H. (to Siemens AG). German Patent 1,949,200. 1 Apr 1971. Filed date 30 Sep 1969. (In German).

A device for the protection of fuel elements in nuclear reactors is characterized by a plate that extends above the entire fuel element area and is fitted with a housing. Immovable supports are welded to the plate. (TSS)

17609 EXPERIMENTAL DETERMINATION OF THE INTEGRAL MASS EXCHANGE IN DEAD-WATER ZONES OF LOCALLY DISTURBED FUEL ELEMENT BUNDLES. Krings, T. Karlsruhe, Ger.; Univ. Karlsruhe (1971). 51p. (In German).

Thesis.

The measuring arrangement and the results of measurements for the determination of the time constants of the mass exchange are given. A flat-shaped baffle barrier is inserted into a test channel and a concentrated aqueous salt solution is used as a test substance to determine the time-dependent concentration changes by means of conductivity measurements. The resulting time constant is plotted against the Reynolds number. The curve of the average dwelling time at the measuring point shows a locally confined maximum within the last third of the dead-water zone, with the dimensionless mass exchange reaching a minimum at this point. (GF)

17610 NUCLEAR REACTOR FUEL ELEMENTS. Butler, F.; Taylor, H. A. (to United Kingdom Atomic Energy Authority). British Patent 1,306,611. 14 Feb 1973. Filed date 13 Apr 1970. 2p.

A method is described for the manufacture of Pu enriched fuel elements consisting of charging the stainless steel sheath with ceramic granules of coarse and fine grades and compacting the mass by vibrocompacting. The coarse grade comprises Pu and U or (Th) in oxide form, while the fine grade consists only of U (or Th) in oxide form. The coarse grade may comprise two fractions, one of which consists of Pu and U (or Th) in oxide form, while the other consists only of U (or Th) in oxide form. The coarse grade may also be intermixed with granules of intermediate size consisting only of U (or Th) in oxide form. The granules may be produced in microsphere form by a sol-gel process. Varied overall enrichments may be obtained by varying the proportions of the grades. (UK)

17611 NUCLEAR REACTOR FUEL ELEMENT. Wilson, E.; Bristow, H. A. S. (to United Kingdom Atomic Energy Authority). British Patent 1,306,612. 14 Feb 1973. Filed date 13 Apr 1970. 2p.

A method is described for the manufacture of Pu enriched fuel elements comprising charging the stainless steel sheath with ceramic granules of coarse and fine grades, and consolidating the mass by vibro-compacting. The coarse grade comprises two fractions, the first being Pu and U (or Th) bearing, while the second is U (or Th) bearing only in oxide forms. The granules may be produced in microsphere form by a sol-gel process. Varied overall enrichments may be obtained merely by varying the ratios of the coarse mixed oxide granules and the coarse U granules. The fine grade granules comprise equal quantities of PuO_2 and UO_2. (UK)

17612 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Seddon, T. (to United Kingdom Atomic Energy Authority). British Patent 1,304,520. 24 Jan 1973. Filed date 3 Sep 1969. 8p.

Reference is made to spacer grids for cluster type fuel elements. Disadvantages of earlier types of spacer grids are stated. The spacer grid described is of cellular form, with openings through which the fuel pins extend. Three rigid support members extend into each opening, and resilient means are provided in each opening in opposed relationship with the support members. The support members are positioned so that their points of contact with the fuel pin are at the corners of a triangle. The arrangement introduces a couple opposing lateral oscillation of the fuel pins between adjacent spacer grids, thus minimizing rubbing fretting of the fuel pins on the support members. The arrangement also limits the amount of disturbances passed on from one intergrid section of the fuel assembly to the next, and ensures correct alignment of the fuel pins within the spacer grids. Various constructional arrangements are described. (UK)

Reactor Control Systems

Refer also to abstracts 15911–15915.

17613 (CONF-721089-1) FLUIDIC SYSTEM FOR DETECTION OF FAILED FUEL IN A NUCLEAR REACTOR. Besant, R. W.; Wilson, J. N. (Saskatchewan Univ., Saskatoon). 1972. 6p. ISA.

From Instrument Society of America and Exhibit conference; New York, New York, USA (9 Oct 1972).

Results are presented of a feasibility study on a fluidic failed fuel detection system. A switching box located within the reactor contains fluidic digital devices and a header. A bleed flow from each coolant line is delivered to a fluidic device having one outlet connected to the header. When switched by an external control signal, the bleed flow is diverted into the header and then to a sample line to monitoring equipment located outside the containment. The condition of the fuel is indicated by the monitor reading. Results are presented on the concentration recovery (or amount of sample dilution) of the bleed flow in passing through the fluidic devices, and the header to the monitoring equipment. Concentration recoveries of 80% or more have been shown to be practical throughout the entire system. The main conclusion is that this type of sampling system using fluidic devices exclusively is feasible and has several distinct advantages over a mechanical system particularly where the system must be located in the severe environments of temperature and radiation. (auth)

17614 (CONF-730904-1) NUCLEAR DESALINATION PLANT CONTROL STUDIES. Ball, S. J.; Clapp, N. E. Jr.; Delene, J. G. (Oak Ridge National Lab., Tenn.). 21 Mar 1973. Contract W-7405-eng-26. 21p. Dep. NTIS $3.25.

From 4th international symposium on fresh water from the sea; Heidelberg, F.R. Germany (9 Sep 1973).

Both theoretical and experimental investigations were made of the problems of controlling large nuclear desalting plants. A general-purpose digital simulator was developed for large multistage flash (MSF) plants coupled to a back-pressure turbine-generator plant with a pressurized-water reactor (PWR) as a heat source. Experimental studies included dynamics tests on MSF and PWR systems. The studies indicate that the overall plant stability characteristics are very sensitive both to the MSF plant hydraulic design features and to the means of coupling the MSF plant to the heat source. (auth)

17615 (MRR-84) REQUIREMENTS FOR ON-LINE COMPUTERS IN NUCLEAR POWER PLANTS. Koehler, B. (Technische Universitaet Muenchen, Garching (West Germany). Laboratorium fuer Reaktorregelung und Anlagensicherung). Nov 1970. 78p. (In German). INIS.

An estimated outlook is given on the prospective functions of process computers in future nuclear power plants, such as supervision of the power plant, determination of the state of the core, and complex control functions. The following topics are discussed: reliability problems, practice-oriented design of a process computer and its peripherals, advantages brought about by the use of minicomputers for special control functions, computer systems with redundant data acquisition, the use of higher programming languages for process computers, and finally some problems encountered by the users of process computers in nuclear power plants. (INIS)

17616 DRIVE DEVICE FOR A NUCLEAR REACTOR SHUTDOWN ROD. Mohm, F. (to Interatom Internationale Atomreaktorbau GmbH). German Patent 1,589,927. 14 May 1970. Filed date 25 Feb 1967. 8p. (In German).

A drive for a reactor scram rod which is connected with a pressure-released lift arranged in a guide tube and provided with a scram piston is described. A spiral spring working in the scram device on the lift is supported by a solid pier. A pivot bar is fastened to the lift. The pivot bar is connected with a stable reset tube by a rocker triggered by a lift magnet with a return spring over a control rod. The lift provided with a scram piston is furnished with a return piston and surrounds the reset tube by formation of a sealed torus connected with a pressure source. The space containing the spiral spring and limited by the guide tube, the return tube, the pier, and the return piston is connected by a duct with a leak and air valve. The rocker is fastened in an extension of the return tube and is connected with the pivot bar to the scram piston of the lift. The return tube is provided with a double piston limiting the torus and surrounds a pressure tube by formation of a ring slot sealed by a ring. (JSR)

17617 DEVICE FOR CONTROLLING AND SHUTTING-DOWN PRESSURIZED-WATER NUCLEAR REACTOR. Schabert, H. P. (to Siemens Aktiengesellschaft). U. S. Patent 3,734,825. 22 May 1973. Priority date 8 Sep 1970, Federal Republic of Germany (F.R. Germany). 8p.

A dual control member is described which serves to control and shutdown a pressurized-water nuclear reactor. It has a control element that includes a plurality of finger control rods secured to a central drive rod through a spider-shaped holder and a shutdown member held by a drive tube surrounding the drive rod and having a separate coaxial spider-shaped holder for a plurality of finger shutdown rods. (Official Gazette)

17618 CONTROL ROD RELEASE MECHANISM. Gilbertson, J. C.; Gorsky, R. A. (to Combustion Engineering, Inc.). U. S. Patent 3,733,251. 15 May 1973. Filed date 22 Jun 1971. 12p.

A control rod release mechanism is described which utilizes a pneumatically actuated mechanical gripper device located immediately above the reactor core region and remotely connected to the control rod drive mechanism. The pneumatic system includes a pressure source which exerts a force on a gripper actuating member in a direction to initiate positive gripping action of a control rod extension shaft by the gripper device. The actuating member is spring biased towards a positive grip release initiating position so that release of the pressure of the pneumatic system will always serve to disconnect the control rod extension shaft from the gripper device. (Official Gazette)

17619 NUCLEAR REACTOR CONTROL ROD DRIVE WITH POSITION ROD INDICATING MEANS. Ripley, C. C. (to General Electric Co.). U. S. Patent 3,734,824. 22 May 1973. Filed date 14 Apr 1969. 12p.

A nuclear reactor control element drive system is disclosed which is capable of both gradual movement during normal reactor operation and high speed insertion in the event of a reactor emergency. This assembly is extremely compact both in length and in permitting close center-to-center mounting. An accurate system for indicating the position to the control elements is included. Safety and reliability are enhanced by a trapped part design which eliminates the need for numerous fasteners and permits rapid, convenient maintenance of the components in the mechanism. (Official Gazette)

17620 BORON CONCENTRATION GRADIENT FOR IMPROVED THERMAL REACTOR PERFORMANCE OF BORON–STAINLESS-STEEL CONTROL RODS. Beaver, R. J.; Richt, A. E. (Oak Ridge National Lab., TN). Nucl. Technol.; 16: No. 1, 187-196(Oct 1972).

From conference on reactor materials performance; Richland, Washington, USA (24 Apr 1972). See CONF-720420-.

An experimental plate-type neutron absorber assembly containing ^{10}B dispersed in Type-200 austenitic stainless steel was irradiated in the active lattice of the 10-MW SM-1 Reactor for 1.2 full power years. The ^{10}B was distributed in a concentration gradient, increasing from 1 wt % in the surface layer to a maximum of 3 wt % 0.024 in. below the surface, to ensure a uniform burnup of ^{10}B atoms in each volume increment through an exposure to thermal neutrons resulting in an average ^{10}B burnup of 20 at. %. Post-irradiation evaluation did not reveal any significant dimensional changes or structural damage to the dispersions at this burnup, which is a demonstration that the use of the boron concentration gradient results in at least a fourfold increase in the reactor performance capability of plate-type neutron absorbers containing dispersions of ^{10}B in stainless steel. (8 figures, 3 tables) (auth)

17621 CONTROL OF SPATIAL XENON OSCILLATIONS. Christie, A. M.; Poncelet, C. G. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Sci. Eng.; 51: No. 1, 10-24(May 1973).

The control of spatial xenon-induced oscillations in large power reactors is considered from the point of view of practical operator manual control. A control strategy is developed based on control theory concepts and considerations of the physics of the problem. It is shown that oscillations can be eliminated by a simple control action consisting of positioning a control rod in a specified location for a specified length of time; upon retrieval of the control rod to its equilibrium position, the flux, xenon and iodine distributions will have returned to equilibrium conditions. A control equation is derived from which the control rod insertion time and the duration of control can be calculated. For large pressurized water reactors of current and anticipated designs, control rod insertion times are in the range from one to four hours before the peak in the oscillation, while control times vary from one-half to two hours. Digital diffusion theory simulations are described which tend to verify the control concepts developed in the paper. Constraints in local power peaking are introduced by considering control at off-optimal times. The study provides guidelines for operator control which is near optimal in the sense that control actions are minimized in number and are most effective in terms of eliminating the oscillation. (auth)

17622 CRT DISPLAY FOR BWR PROCESS COMPUTER. Neda, T. (Tokyo Shibaura Electric Co. Ltd., Fuchu, Japan); Hino, T.; Ito, M. Toshiba Rebyu; 28: No. 2, 192-195(Feb 1973). (In Japanese).

The process computer is now indispensable for operation of BWR plants. The marked growth of utility value of the process computer is due to the progress of computer hardware and software techniques. For quick and precise transmission of complicated and multifarious information, the color CRT display has been introduced as a means of improved man-machine communication in BWR plants. The CRT display for this purpose is outlined. (auth)

17623 POWER DISTRIBUTION CONTROL SYSTEM OF THE RBMK REACTOR. Emel'yanov, I. Ya.; Konstantinov, L. V.; Postnikov, V. V.; Denisov, V. K.; Gurovich, V. Ya. At. Energ. (USSR); 34: No. 5, 331-334(May 1973). (In Russian).

The main features of the power distribution control system of the Atomic Power Station RBMK reactor are described. The radial power distributions are measured by 117 beta-emission neutron detectors, the sensors of which are in the form of heat-resistant cable (3-mm OD, 6-mm long) with silver emitters. Detectors for in-core measurements are mounted in the control thimble of the fuel channel. The axial distributions are measured by means of 12 detector assemblies, consisting of 7 sensors of the above-mentioned type. They are mounted in empty lattice cells. Detector signals are fed to the instrument portion of the system, which signals deviations from preset levels. An on-line digital computer calculates the power of every fuel bundle, the burnout safety factor and reactor operation reliability. (auth)

17624 TEMPERATURE CONTROL IN SINGLE-PHASE COOLANT REACTORS. Ernst, H. (to Licentia Opatent Verwaltungs GmbH). German Patent 1,945,300. 11 Mar 1971. Filed date 6 Sep 1969. (In German).

The regulation of temperature at the outlet for a single-phase coolant reactor is characterized by the facts that the amount of adjustment at the outlet forms both the indication of the power of the reactor and the value of the alignment of the circuit for the secondary regulation for the coolant flow. The regulator of the circuit for the regulation of flow determines the number of circuits starting at least with a regulating circuit for the number of circuits that starts the movement of the coolant (pump, fan). (TSS)

17625 ANALYSIS OF CONTROL-ROD-SYSTEM MALFUNCTIONS IN NUCLEAR POWER REACTORS. Duma, D. W.; Saxe, R. F. (North Carolina State Univ., Raleigh). Nucl. Safety; 14: No. 4, 315-323(1973).

Control-rod-system failures and malfunctions are reviewed for all of the nuclear power reactors from inception to commercial operation through 1971. Failure rates are calculated and types of faults analyzed for common causes. System performances are compared for the major vendors of pressurized- and boiling-water reactors as well as others. Results indicate that overall failure rates for the reactors considered are not widely variant. (auth)

Nuclear Power Plant Economics

Refer also to abstract 17426.

17626 (INIS-mf-395) NUCLEAR POWER: WORLD AND AUSTRALIAN SITUATION IN PERSPECTIVE. Alder, K. F. (Australian Atomic Energy Commission, Coogee). Aug 1972. 30p. (CONF-720846-1). INIS.

From 44th congress of the Australian and New Zealand Association for the Advancement of Science symposium; Sydney, Australia (14 Aug 1972).

The current status and likely future of nuclear power are discussed in the context of power generation from all sources. The incentives to develop nuclear power are reviewed. Safety, reliability and environmental aspects, fuel cycle characteristics and fast breeder developments are discussed with particular reference to Australian planning. (AT)

17627 ENERGY CRISIS AND NUCLEAR POWER. Hill, J. (United Kingdom Atomic Energy Authority, London). Atom (London); No. 199, 107-110(May 1973).

The main topics discussed are the world energy shortage (real and imaginary), the role that nuclear power can play in mitigating this shortage, and what has to be done to provide an efficient and profitable nuclear industry in the UK that can compete in the world market. (UK)

17628 NUCLEAR INDUSTRY CHART. No. 16 Japan. Nucl. Eng. Int.; 18: No. 206, 548(Jul 1973).

A pull-out chart is presented of the Japanese nuclear industry showing the major natural bodies, private organizations, and major industrial groupings. Their interests and relations with foreign associations are illustrated. (UK)

17629 PRESENT SCOPE AND SPECIALITIES OF JAPANESE NUCLEAR INDUSTRY. Mori, K. (Japan Atomic Industrial Forum, Inc., Tokyo). Nucl. Eng. Int.; 18: No. 206, 548-550(Jul 1973).

The main topics discussed are the size and financial state of the Japanese nuclear industry, its market prospects, the capabilities of the nuclear supply industry, the use of foreign technology, and future nuclear plant schedules. (UK)

17630 ACCOUNTING FOR RELIABILITY OF FUEL CHANNELS IN ATOMIC POWER STATION ECONOMICS. Bryunin, S. V.; Koryakin, Yu. I.; Novikov, V. Ya. At. Energ. (USSR); 34: No. 5, 335-339(May 1973). (In Russian).

A method of calculating engineering economic indexes of reactor cores, taking into account quantitative reliability characteristics of fuel cores, is presented. The method is intended for approximate economic comparison of reactor cores of different reliability during the design stage and is an integral part of the general method of determining engineering economic indexes at atomic power stations. (auth)

17631 NUCLEAR POWER PROGRAMME IN THE UNITED KINGDOM. Cavendish-Bentinck, V. F. W. (British Nuclear Forum, London). Kerntechnik; 15: No. 4, 155-157(1973).

British nuclear power plants already in operation and their economic situation are discussed briefly. Changes which have arisen in the structures of governmental organizations and companies active in the nuclear field are described. (GE)

17632 JAIF REPORT ON STATE OF NUCLEAR INDUSTRY. Hashimoto, S. (Japan Atomic Industrial Forum, Inc., Tokyo). At. Jap.; 16: No. 4, 16-22(Apr 1972).

The state of the nuclear industry in Japan is reported. As the conclusion of a vast investigation, Japan will be forced to depend on atomic energy as a power source. Last year, the Japan Atomic Industrial Forum presented its "Nuclear vision for the year 2000," forecasting that Japan's nuclear power facilities would have a production capacity of 27,000 MW(e) by 1980, and 220,000 MW(e) by 2000. Japan's four existing nuclear power plants with the total capacity of about 1300 MW(e) are making a good showing, but environmental problems have awakened the public to the social effect of nuclear power development. The choice of a site for a power plant is a serious problem. Problems of waste are the subject of study. Demand for more enriched uranium will make it necessary to have another enrichment plant by the beginning of the 1980's. Concerning the treaty, Japan has done all in its power to fulfill the conditions of international safeguards. (JA)

17633 NUCLEAR POWER STATIONS IN THE GERMAN FEDERAL REPUBLIC. Huenlich, W. H. F. (Vereinigung Deutscher Elektrizitaetswerke eV, Frankfurt am Main). At. Strom; 19: No. 3/4, 30-33(1973). (In German).

On the basis of the present state of development of the nuclear power station capacity in the European Community and in the world, a report on the installations at present in operation in the German Federal Republic as well as on those which are being built or in the planning stage is given. The problems are mentioned which electricity supply undertakings may encounter when planning new power stations. (GE)

Reactor Fuel Cycle Economics

Refer also to abstract 17370.

17634 (COO-3422-1) CORE MANAGEMENT PROGRAM TO OPTIMIZE FUEL UTILIZATION IN TRIGA RESEARCH REACTORS. Naughton, W. F. . (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Sep 1972. Contract AT(11-1)-3422. 147p. Dep. NTIS $9.50.

Thesis.

A fuel management program to establish optimum TRIGA fuel utilization and fuel procurement schedules to minimize fuel costs is presented. 19 references. (auth)

17635 NUCLEAR FUEL CYCLE ACTIVITIES IN JAPAN. Imai, R. (Japan Atomic Power Co., Tokyo). Nucl. Eng. Int.; 18: No. 206, 553-555(Jul 1973).

The role of the fuel cycle industry in maintaining the balance between the supply and demand for electricity in Japan, estimated as 220,000 MW(e) by the year 2000, is discussed in an attempt to identify the main future issues. The position relating to fuel processing and reprocessing is examined and the layout of the new PNC plant is shown. Problems of U enrichment which

are specific in Japan are discussed and suggestions are made for diversifying source supplies. Brief mention is also made of waste disposal, spent fuel transportation, and safeguards. (UK)

Reactor Licensing and Regulation

17636 (DOCKET-50443-6) SEABROOK STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 1. (Public Service Co. of New Hampshire, Seabrook (USA)). Jun 1973. 353p. (DOCKET-50444-6). Dep. NTIS $20.00.

The general description and site characteristics of the Seabrook Station are presented. The plant consists of two pressurized water reactors for operation at core power levels up to and including 3411 MW(t), a nuclear steam supply thermal output of 3425 MW(t) and a corresponding net electrical power output of 1194 MW(e). Each unit is housed in a reinforced concrete primary containment structure and a concrete secondary containment structure. Scheduled completion date for unit 1 is May 1979 and anticipated commercial operation date is November 1979 with the completion date for unit 2 scheduled for March 1981 with commercial operation in September 1981. (FS)

17637 (RAI-73-6) REGULATORY ADJUDICATION ISSUANCES, June 1973. (Technical Information Center (AEC), Oak Ridge, Tenn.). 15 Jul 1973. 93p. TIC.

Issuances received from the U. S. Atomic Energy Commission, the Atomic Safety and Licensing Appeal Boards, and the Atomic Safety and Licensing Boards are presented. (HDR)

17638 (RDT-STATUS-5-73) BIMONTHLY STATUS REPORT OF RDT STANDARDS FOR THE PERIOD ENDING MAY 31, 1973. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 19 Jun 1973. 45p. RSO.

17639 (TID-26300) ISSUANCES OF THE ATOMIC ENERGY COMMISSION AND THE ATOMIC SAFETY AND LICENSING BOARDS, JULY–DECEMBER 1972. (Technical Information Center (AEC), Oak Ridge, Tenn.). Jul 1973. 256p. Dep. NTIS $7.60.

17640 LAW OF 12th MAY 1972, NO. 28, ON ATOMIC ENERGY ACTIVITIES. Oslo; Groendahl og Soen (1972). 25p. (In Norwegian).

The law of 12th May, 1972, nr. 28 defines the requirements regarding concessions and licensing for nuclear power plants and fuel fabrication plants, isotopic separation plants, plants for long term shortage of fuel and other radioactive materials etc. The law also defines the status and authority of the State Nuclear Inspectorate and the procedures to be followed in licensing the construction and operation of nuclear plants. Insurance requirements are also defined as are legal procedures following an accident. Ship reactors are also covered in the law. (NO)

17641 ACTIVITIES OF THE GERMAN STANDARDS COMMITTEE FOR NUCLEAR TECHNOLOGY. Neider, R. J. A. (Federal Inst. of Materials Testing, Berlin). Nucl. Safety; 14: No. 3, 181-186(1973).

The increasing demand for nuclear standards to facilitate the siting, design, and licensing of nuclear power plants is evident in Germany as in most other countries with a viable nuclear capability. As a result, the German Standards Institute's Nuclear Technology Committee has recently intensified its effort. In addition, several German technical societies are involved in the standardization effort, and Germany cooperates in the International Standards Organization activities. (auth)

17642 DEVELOPMENT AND UTILIZATION OF ATOMIC ENERGY IN JAPAN. Inouye, G. (Atomic Energy Commission, Tokyo). Nucl. Eng. Int.; 18: No. 206, 541(Jul 1973).

A synopsis is given of the function of the Japan Atomic Energy Commission in promoting measures on atomic energy development and in the management of its administration. (UK)

17643 SAFETY, ENVIRONMENT, AND LICENSING PROBLEMS OF NUCLEAR POWER PLANT IN JAPAN. Uchida, H. (Tokyo Univ.). Nucl. Eng. Int.; 18: No. 206, 560-562(Jul 1973).

Licensing and regulatory procedures for building nuclear power plants in Japan are outlined. The evaluation of safety for normal operation of a reactor, and also for postulated accident conditions, is discussed and countermeasures considered. (UK)

17644 BOTTLENECKS IN THE LICENSING PROCEDURES. Smidt, D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 18: No. 3, 116-121(1973). (In German). (AED-CONF-72-415-007).

From specialist's meeting: the reactor protection system as a main safety installation in nuclear power plants; Cologne, Ger. (20 Nov 1972).

It is feared that some of the nuclear power stations now being planned or under construction in the FRG will not be completed on time due to bottlenecks in the licensing procedures. The basis for these fears lies in the steeply rising number of licensing processes, the further development of safety technology and its repercussions on requirements as well as the increasingly critical attitudes of the public. One main problem is the lack of communication between the authorities and the experts, the reactor manufacturers and operators, the Reactor Safety Commission, etc. It is hoped that a new information system RESI (Reactor Safety Information System) will improve this situation. A further problem is that of standardization in view of the long times required by the Nuclear Technical Committee (Kerntechnischer Ausschuss, KTA) to work out the technical standards. A timely recognition of the problems and the implementation of the appropriate measures can ensure that nuclear power stations are not delayed by the licensing procedures. (GE)

17645 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Cottrell, W. B. Nucl. Safety; 14: No. 4, 387-408(1973).

GENERAL

Civilian Defense

Refer also to abstract 15710.

Energy Utilization and Economics

17646 (CONF-730811-4) TECHNOLOGY EVALUATION FOR MIUS. Miller, A. J.; Samuels, G.; Boegly, W. J.; Breitstein, L. (Oak Ridge National Lab., Tenn.). 1973. 7p. Dep. NTIS $3.00.

Modular integrated utility systems (MIUS) would provide developing communities with energy, water, and sanitary services from a single utility employing a total system concept to balance the requirements for environmental quality, conservation of resources, and low total costs. The MIUS may be sized to accommodate perhaps 100 to 3000 multifamily dwelling units, nearby single-family housing, and associated commercial facilities. The technology necessary to build a MIUS currently exists. An on-site utility with power generation based on prime movers, such as diesel engines or gas turbines and on use of recovered thermal energy for heating and air conditioning, could be significantly more efficient in energy utilization from fuel than new conventional systems in most parts of the U.S. The costs of the on-site energy utility service would be in the same range as service from most new conventional systems. Incineration of solid waste with heat recovery would result in significant conservation of fuel. Liquid waste could be adequately treated on-site. Emissions of air pollutants and ambient air quality resulting from MIUS would conform to present and currently projected standards. (MCW)

17647 (LA-UR-73-570) SOME INTERFACES IN RESOURCE UTILIZATION. Reinig, L. P. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 16p. (CONF-730440-1). Dep. NTIS $3.00.

Los Alamos Scientific Laboratory is engaged in programs to explore the ways of extracting useful power from the heat of the Earth's crust; to demonstrate the feasibility of superconducting transmission lines; and to develop a rock-melting penetrator, or subterrene, expected to be capable of creating long tunnels in rock. The tunnels, lined with the glass-like melted rock created by passage of the subterrene, might form excellent conduits for underground transmission lines, as well as serving in the exploitation of geothermal energy. A project to exploit the vast underground reservoir of saline water in New Mexico is described. The project TRG is based on desalination by means of geothermal or nuclear energy to furnish New Mexico with water and electric power. (MCW)

17648 (ORNL-NSF-EP-39) SECOND ITERATION ANALYSIS OF A FOSSIL FUEL-FIRED GAS TURBINE–POTASSIUM–STEAM COMBINED CYCLE. Lackey, M. E. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 32p. Dep. NTIS $3.75.

The operating conditions and heat balance of the fossil fuel-fired potassium vapor topping cycle as proposed in an initial ORNL study carried out under the NSF-RANN program have been reexamined in considerable detail. It appears desirable to reduce the peak temperature in the steam system as well as make a number of modifications in the feed heating system. Gas turbine operating experience has been reviewed to provide a firm basis for choosing the turbine inlet temperature and component efficiency for the gas turbine cycle. On the basis of these analyses the operating conditions of the initial study were modified and a new flow sheet and heat balance were prepared using the supercritical pressure steam cycle of the TVA Bull Run steam plant as the point of departure. This gave an overall combined cycle efficiency of 52% and a net heat rate of 6580 Btu/kW-hr. (auth)

17649 (ORNL-NSF-EP-53) ENERGY IMPLICATIONS OF SEVERAL ENVIRONMENTAL QUALITY STRATEGIES. Hirst, E. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 34p. Dep. NTIS $3.75.

The amounts of energy needed for or saved by operation of several environmental protection strategies are examined. The areas considered include: urban passenger traffic, waste water treatment, solid waste management, air-pollution control, and waste heat dissipation. The energy costs and savings of a shift to mass transit from automobiles, of automobile air-pollution-control devices, and of energy-efficient automobile designs are examined. Electric energy costs are determined for primary and secondary sewage treatment plants as functions of plant size. Energy costs and savings are computed for solid waste disposal, recycle, and use as fuel. Energy needs for air-pollution control at stationary sources are evaluated. Finally, several options for improving energy-use efficiency are noted. The energy required to meet the environmental needs discussed—based on the limitations and assumptions in this study—are small relative to total energy use. (auth)

17650 (ORNL-NSF-EP-55) ELECTRICAL ENERGY AND ITS ENVIRONMENTAL IMPACT. Progress Report, June 30, 1973. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 67p. Dep. NTIS $5.50.

Major results are placed on the analysis of energy uses in the residential and transportation sectors, but a new topic is the exploration of the energy cost of food that turns out to be several times larger than the energy content of food. The analysis of energy uses is discussed concerning energy requirements for environmental quality; energy costs of food; energy conservation; transportation energy; efficiency and economics of room air conditioners; residential energy; and a report on residential consumption of electricity, 1950 to 1970. The electricity demand in the USA and the TVA area are cited. An evaluation of alternative reclamation techniques for coal surface mining in Appalachia is made, along with its economical aspects and implementation. The disposition of trace elements from coal combustion at the TVA Thomas A. Allen Steam Plant in Memphis, Tennessee is being investigated. (JCW)

17651 (SLA-73-5318) COMBINATION OF SOLAR ENERGY AND THE TOTAL ENERGY CONCEPT: THE SOLAR COMMUNITY. Pope, R. B.; Schimmel, W. P. Jr.; Lee, D. O.; McCulloch, W. H.; Bader, B. E. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 8p. (CONF-730811-5). Dep. NTIS $3.00.

The feasibility of using solar energy to provide most of the residential energy needs in a coherently designed Solar Community is investigated analytically. This innovative concept of a Solar Community is based upon the premise that solar energy can be collected, stored, and then used to provide electricity (through Rankine cycle turbines and electric generators) and comfort conditioning. As designed, solar energy is backed up with supplementary fossil fuel for the periods when stored solar energy is depleted. Five different Solar Community concepts are analyzed and evaluated in terms of projected fuel savings and annual total energy costs. The system that appears most promising is a cascaded system using focused collectors, storage, and a derated turbine where the exhaust energy is "cascaded" into sensible heat storage for use in comfort conditioning. Depending upon the system chosen, annual fuel savings of 45 to 65% could be obtained. Economic parity with existing systems could occur in the 1980's or early 1990's, based upon a moderately increasing utility rate schedule. If utility costs become prohibitive, the proposed system could become competitive much sooner. (auth)

17652 (SLA-73-5320) NEW PARAMETER FOR EVALUATING ENERGY SYSTEMS. Lee, D. O.; McCulloch, W. H. (Sandia Labs., Albuquerque, N. Mex.). 1973. 4p. (CONF-730811-2). Dep. NTIS $3.00.

Thermodynamic systems have generally been characterized by their thermal efficiency that is defined as the ratio of work done by the system to the energy input. However, systems are now being designed that make use of the heat that would normally have been rejected by prime movers. For such systems, the thermal efficiency of the cycle is not an appropriate measure of the merit of the system. A more appropriate way to characterize these types of systems would be to apply the second law of thermodynamics and to determine the availability of the energy supplied to the system. The availability in turn may be compared to the utilization, which is defined as the useful work output plus the applied heat, by defining the utility (Y) of the system as the ratio of the utilization (y) to the availability (A_y). The utility of a system, as defined above, is a meaningful measure of the total benefit derived from a system in comparison to the ideal maximum which might be obtained. The concept is developed and its use is illustrated. (auth)

17653 GEOTHERMAL ENERGY. Resources, Production, Stimulation. Kruger, P.; Otte, C. (Eds.). Stanford, CA; Stanford University Press (1973). 369p. $17.50.

Abstracts were prepared for eighteen papers presented at the special symposium held by the American Nuclear Society in June 1972. Individual papers discuss available and potential resources throughout the world, methods of exploration and evaluation, geological and geochemical character of the resources, problems in developing the several types of resources, the current status of geothermal energy production in the US and elsewhere, potential methods for more efficient production, the impact on the environment, and possible uses as a water resource. The final paper re-

views the needed areas of research and Federal efforts to coordinate exploration, research, and development. (MCW)

For abstracts of individual papers see: 17654–17671.

17654 INTRODUCTION: THE ENERGY OUTLOOK. Otte, C.; Kruger, P. (Union Oil Co. of California, Los Angeles). pp 1-13 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

It is shown that to date the United States has supported its population expansion, its economic growth, and its high standard of living by means of an accelerating utilization of low-cost energy–energy derived from a bountiful endowment of domestic fossil-fuel resources. Fossil fuels are finite in amount and nonrenewable in periods less than millions of years. The limits of the fossil energy supplies are going to be reached. The increasing awareness of the exponential growth of energy consumption, the rapid depletion of our natural resources, the lagging development of new energy resources and technologies, the strain on the dollar in world markets, and the growing public and institutional demands for energy and materials conservations and environmental protection have forced the Federal government to plan for the nation's energy economy. These programs and the resulting data from the studies are discussed. Facts are presented for present fossil and nuclear fuel resources and consumption. An assessment is made of the contribution of geothermal energy to the energy demand during the next few decades. It is forecasted that the US could be producing at least 132,000 MW of electric power from its geothermal resources in 1985. (MCW)

17655 WORLDWIDE STATUS OF GEOTHERMAL RESOURCES DEVELOPMENT. Koenig, J. B. (California Div. of Mines and Geology, Sacramento). pp 15-58 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

A summary is given of the distribution of geothermal resources on a worldwide scale, of the development and exploration activities, and an evaluation of the potential for development over the next decade. The development and exploration is reviewed for many countries and the potential for geothermal energy development to 1980 is discussed. A conservative projection of worldwide geothermal generation by 1980 is about 2500 Mw, or three times that of the 1970s. Much source material was used, but individual citations are not noted. Reference is made to Proceedings of the United Nations Conference on New Sources of Energy, Solar Energy, Wind Power and Geothermal Energy, Rome, Aug. 1961; v. 2,3, Geothermal Energy, New York: United Nations, 1964 and Proceedings of the United Nations Symposium on Development and Utilization of Geothermal Resources, Pisa, Italy, Sept., 1970; Geothermics, Special Issue 2, 2 volumes, 1971. (MCW)

17656 ASSESSMENT OF U. S. GEOTHERMAL RESOURCES. Rex, R. W.; Howell, D. J. (Univ. of California, Riverside). pp 59-67 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

The energy of the heat of the Earth's interior is far greater than all the available uranium and thorium that could be utilized in breeder reactors. The extent of the resource to be developed with present technology and at an acceptable cost is discussed. It is demonstrated in the operating geothermal plants in California that certain geothermal types are feasible, practical, and economical. Current geothermal developments center on dry-steam and hot-water systems. Technological advances must be made to develop hot, dry rock systems of rock fracturing; geothermal drilling in the range of 20,000 to 30,000 feet depth with holes evenly distributed across the US to appraise the total US deep potential; and power-conversion technology for low-temperature hot-water geothermal systems. (MCW)

17657 CHARACTERISTICS OF GEOTHERMAL RESOURCES. White, D. E. (Geological Survey, Menlo Park, CA). pp 69-94 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Requirements for the production of electricity from geothermal steam include reservoirs of high temperature (at least 180 or 200°C) depths of less than 3 km, natural fluids for transferring the heat to the surface and power plant, adequate reservoir volume (>5 km^3), and sufficient reservoir permeability to ensure sustained delivery of fluids to wells at adequate rates. This configuration is absent generally, so new technology is needed to exploit geothermal heat. The geothermal systems of the world, dominated by vapor or by hot water, are generally associated with tectonic-plate boundaries and volcanic activity. Fields along the belt of mountains extending from the Mediterranean eastward through Turkey to the Caucasus are related to the complex zone of collision between the Eurasian and African continents. Detailed plate-boundary relations of the western US and central Mexico are not clearly established. Temperatures below the Earth's surface are controlled principally by conductive flow of heat through solid rock, by convective flow in circulating fluids, or by mass transfer in magma. Hydrothermal-convection systems, hot-water systems, and vapor-dominated systems and their locations are discussed. The recoverability and reserves of potentially useful concentrations of geothermal heat near the surface of the Earth are discussed in view of some important breakthroughs in utilization technology. (50 references) (MCW)

17658 EXPLORATION FOR GEOTHERMAL RESOURCES. Combs, J. (Univ. of California, Riverside); Muffler, L. J. P. pp 95-128 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

The various methods available for the exploration, discovery, and delineation of economic reservoirs of geothermal energy are discussed. Each prospecting site represents unique requirements. Various combinations of geological, hydrological, geochemical, geophysical, technical, or financial characteristics exist. A literature search is helpful to perhaps delete certain areas for exploration if certain data are already known. Interpretation of modern aerial photography is important in initial geothermal exploration. Data acquired from drill holes furnish temperature-depth distribution, pressure-depth distribution, permeability, porosity, lithology, stratigraphy, and fluid composition. Exploration procedures are given in detail for the Broadlands geothermal field, New Zealand and the Mesa geothermal anomaly, southeastern California. (81 references) (MCW)

17659 STEAM PRODUCTION AT THE GEYSERS GEOTHERMAL FIELD. Budd, C. F. Jr. (Union Oil Co. of California, Cloverdale). pp 129-144 of Geothermal Field. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

At the Geysers in northern Sonoma County, California, the dominant geothermal fluid phase is gaseous steam, a condition existing only in a few commercially producing fields, examples of which are Larderello field, in Italy and the Matsukawa field, in Japan. The extractive system is basically a well, drilled to a depth sufficient to encounter geothermal fluids, cased, and completed to provide a stable conduit through which the fluids can flow to the surface, and furnished with the facilities necessary to control and transport the fluids to their point of utilization that must be near the wellbore since the fluid loses its heat rapidly. Marketing, drilling operations, reservoir performance, production management, and reinjection operations at the Geysers are discussed. (MCW)

17660 DESIGN AND OPERATION OF THE GEYSERS POWER PLANT. Finney, J. P. (Pacific Gas and Electric Co., San Francisco). pp 145-161 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ., Press (1973).

The research and design evolution of the several power units now in operation at the Geysers are discussed. The Pacific Gas and Electric Company has been engaged in the design, construction, and operation of the dry-steam geothermal electric-power generators there for fifteen years. The plant's eight turbine-generator units produce a net output of 290,000 kw. Two more 53,000-kw units are scheduled to go into operation in 1973. In 1974, after a single unit rated at 106,000 kw goes into operation, the total net output of the The Geysers Power Plant will be 502,000 kw, making it the largest geothermal-power installation in the world. Power-production costs compare favorably with those of PG&E's fossil-fuel steam-generating units. (MCW)

17661 VAPOR-TURBINE CYCLE FOR GEOTHERMAL POWER GENERATION. Anderson, J. H. (Consulting Engineer, York, PA). pp 163-175 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

A geothermal-power process, the vapor-turbine cycle, was developed for the conversion of geothermal heat to power by transporting the heat from the source to the surface. The obvious means is fluid flow and water is the chosen fluid. The hot water brought to the surface is passed through a heat exchanger, where it gives up heat to boil and superheat a high-density vapor. The vapor then expands through a turbine to produce power and is recycled to the heat exchanger. The cooled water is injected into a well nearby, carrying all dissolved gases and most of the solids in solution with it. The water thus injected maintains the underground reservoir pressures and very likely finds its way back through the hot porous zone to be reheated. The advantages of using isobutane in the power cycle are given. The many advantages of the vapor-turbine cycle using isobutane or other suitable fluids over the flashed-steam or indirect steam-heating cycles are enumerated. (MCW)

17662 WATER FROM GEOTHERMAL RESOURCES. Laird, A. D. K. (Univ. of California, Berkeley). pp 177-196 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Small-scale geothermal power production and some water production units are in operation throughout the world. In these units

water carries thermal energy from the reservoirs to the surface. In some cases, condensate from steam turbines may be available as fresh water supplies. Since liquid water produced from geothermal wells is generally saline and already hot, distillation could be a means for making more fresh water available. Large-scale geothermal distillation as a component of energy-production schemes has been studied. It may be advantageous to employ the electricity thus generated to desalinate sea water at some remote location. For this situation, membrane desalting is more appropriate than distillation. Geothermal reservoirs are classified as hot-water, or liquid-dominated, since they produce principally liquid, and as steam, or vapor-dominated, systems where they contain mostly steam. Liquid-dominated reservoirs are the most readily available and are used as examples discussed for geothermal desalination. (MCW)

17663 ENVIRONMENTAL IMPACT OF GEOTHERMAL DEVELOPMENT. Bowen, R. G. (Oregon Dept. of Geology and Mineral Industries, Portland). pp 197-215 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Geothermal power plants utilize naturally occurring steam, need no complex steam-generating equipment or extensive mining, processing, storage, or transportation facilities, as do other thermal power plants. Some disturbance of the land will occur during construction of the steam-gathering lines and power plants, but afterwards, the land can be used for other purposes. At Larderello, farms, orchards, and vineyards cover the area. Natural steam does contain minor amounts of carbon dioxide, nitrogen, hydrogen, methane, and hydrogen sulfide that are vented to the air. Dry-steam geothermal developments pose no hazard to water supplies. Dry-steam and flashed-steam power plants supply their own cooling water by condensing their steam, and are therefore independent of the sources of condenser cooling water that are needed by other types of thermal plants. Hot-water geothermal systems will have an effect on the waters, but in most cases it will be to bring into use waters that are below the economic drilling depths of water that is currently in use, or to upgrade the quality of currently unusable waters, thus making these waters themselves a valuable resource. (22 references) (MCW)

17664 STIMULATION OF GEOTHERMAL SYSTEMS. Ewing, A. H. (Atomic Energy Commission, Washington, DC). pp 217-222 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Artificially stimulated geothermal systems include geothermal steam, hot-water, and hot, dry rock formations. Considering naturally occurring geothermal systems lying at depths of less than 3 km, and assuming that 1% of the heat energy in such systems is recoverable by present technology, it is estimated that 2×10^{19} calories are available. And at depths up to 10 km, the total energy available in such systems is estimated to be about 500 times greater, though its exploitation would require improvements in the technology of drilling and stimulating marginal systems. More energy would become available if methods were developed to recover energy from hot, dry rocks. The development of the vapor-turbine cycle would allow for heat-extraction from lower-temperature resources (less than 180°C). Prospects for artificially stimulating the productivity of economically submarginal geothermal-steam fields, hot-water aquifers, or hot, dry-rock formations hold promise. (MCW)

17665 RECOVERY OF GEOTHERMAL ENERGY FROM HOT DRY ROCK WITH NUCLEAR EXPLOSIVES. Burnham, J. B.; Stewart, D. H. (Battelle-Northwest Research Labs, Richland, WA). pp 224-230 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Geothermal energy constitutes a significant energy source that can be recovered with the use of nuclear explosions. The economic potential of this energy source is comparable to that of most mining operations that require the fracturing of rock; the economics are highly dependent on the efficiency with which the rock can be fractured. The Plowshare geothermal concept is a project described by the American Oil Shale Corporation et al. (1971) that entails the generation of power from energy contained in deposits of hot, dry rock. The rock is fractured by an array of sequentially fired, fully contained nuclear explosives. Water is injected through fill pipes and steam is withdrawn to the surface facility. The Plowshare geothermal project furnishes the details of plant design and the technical and economic assumptions. A relationship is given between the number of nuclear explosives required, the energy recovered from the nuclear explosives (that portion of the energy from the explosion that remains locally in the form of heat), and the energy extracted from the hot rock. (MCW)

17666 EXPLOSIVE STIMULATION OF HYDROTHERMAL RESERVOIRS. Ramey, H. J. Jr.; Kruger, P.; Raghavan, R. (Stanford Univ., CA). pp 231-249 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

The geothermal aquifer can become an important source of electrical power if the vapor-turbine power cycle is realized and the explosive stimulation process of geothermal-fluid production that creates an open reservoir in or adjacent to a fluid-bearing aquifer is developed. Methods for the optimum removal of geothermal fluids must be based on a thorough knowledge of the recovery mechanisms operating within the reservoir, including fluid expansion, liquid vaporization, and the segregation of liquid and vapor (gravity drainage), as well as the influx of fluids from adjacent or underlying aquifers. The deposition and production of minerals must be considered, as well as the environmental effects due to the explosion and subsequent geothermal production. An evaluation of geothermal-aquifer stimulation requires study of thermophysical, hydrodynamic, and chemical parameters. The subjects covered in the paper include energy aspects of hydrothermal reservoirs, explosive stimulation, environmental effects, production methods, and performance forecasting. (MCW)

17667 INDUCTION AND GROWTH OF FRACTURES IN HOT ROCK. Smith, M.; Potter, R.; Brown, D.; Aamodt, R. L. (Los Alamos Scientific Lab., NM). pp 251-268 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Concepts are presented to produce geothermal energy from hot, relatively dry rock by circulating a fluid introduced from the surface through the rock and bringing the heated fluid (probably water) back to the surface. Hydraulic fracturing is begun by pumping water from the surface into a borehole. When the borehole becomes sufficiently pressurized, a tensile crack will form. The fracture will grow as the pumping continues and will continue to grow as long as water can be pumped in fast enough to exceed the leakage taken off by the permeability of the rock. Calculations and computer simulations are made of the behavior of the reservoir. The procedure is explained in detail and an experiment in the Jemez Mountains about 2 to 5 miles west of the Valles Caldera, and about 30 miles west of Los Alamos Scientific Laboratory is planned. Appendix A compares steam- and water-dominated energy transport from the reservoir; Appendix B describes the void generated per million Btu of heat energy withdrawn from rock; Appendix C discusses the temperature at which thermal fracture occurs vs depth. (MCW)

17668 CHEMICAL EXPLOSIVE STIMULATION OF GEOTHERMAL WELLS. Austin, C. F.; Leonard, G. W. (Naval Weapons Center, China Lake, CA). pp 269-292 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

A granite rock area in eastern California is used as an example to examine ways in which explosive stimulation of geothermal wells may be employed. Various rock materials follow their own fundamental behavior patterns. Various shapes are studied. Current explosive technology permits the construction of explosive-stimulation charges for temperatures up through 400°C. The behavior of cased and uncased explosives is discussed. Technology of explosive-stimulation of rock formations at elevated temperatures and with fluid saturation is in the experimentation stage. (MCW)

17669 ENVIRONMENTAL ASPECTS OF NUCLEAR STIMULATION. Sandquist, G. M. (Univ. of Utah, Salt Lake City); Whan, G. A. pp 293-313 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

The environmental effects of producing electric power from natural geothermal sources with nuclear stimulation were discussed. There are no operational nuclear-stimulated geothermal sites, but the AEC has accumulated extensive theoretical and experimental data related to underground nuclear tests. The environmental aspects are classified into three periods associated with the life cycle of a geothermal site: pre-plant operations, plant operations, and post-plant operations. Deep dry-rock stimulation favors the use of very large explosives, which would produce severe environmental impact from seismic effects. Geothermal-aquifer stimulation would make use of smaller nuclear devices, but because of the probable affinity to tectonic-plate boundaries of the geologic formations addressed by this application, the potential environmental impact of radioactive contamination would be a serious concern, as would possible induced seismic fault movement. When underground nuclear-explosive stimulation is undertaken, the primary concern will remain the large quantity of radioactive materials deposited within the ground and the potential for unacceptable release of these materials in the future. (30 references) (MCW)

17670 CORROSION AND SCALING IN NUCLEAR-STIMULATED GEOTHERMAL POWER PLANTS. Krikorian, O. H. (Univ. of California, Livermore). pp 315-334 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

A study was made of the problems that can result from mineral deposition on the piping, in the steam turbine, and in the condenser

of a nuclear-stimulated geothermal power plant. It has been shown that the deposition of salts and silica (and associated radioactivity) on turbine blades is dependent on the impurities in the steam and on the steam pressure. Scaling studies on steam-turbine blades are useful in interpreting and predicting the steam-transport behavior of minerals in geothermal applications, both in the underground well and through the power cycle. This study involves the problem areas to steam effects in hot, dry-rock systems or dry-steam geothermal fields. Corrosion problems in a mixed water/steam field or in a hot-water field can be assumed to be more severe than those in dry-steam systems. Mineral content, radioactive-materials content, and noncondensable-gas content of the steam is studied throughout the system. (22 references) (MCW)

17671 GEOTHERMAL RESOURCES RESEARCH. Denton, J. C. (National Science Foundation, Washington, DC); Dunlop, D. D. pp 335-346 of Geothermal Energy. Kruger, P. (Ed.). Stanford, CA; Stanford Univ. Press (1973).

Various U. S. government agencies are conducting research directed toward an increased understanding of geothermal resources. The agencies are listed and their involvement is discussed concerning resource exploration, resource evaluation, reservoir development and production, utilization technology and economics, environmental effects, and institutional considerations that permit geothermal development in a manner deemed safe, economical, environmentally sound, and equitable for all parties concerned. These parties are chiefly the general public as users, private industry as developers, and local, state, and Federal governmental agencies as regulators. The program should emphasize the development of the vapor-turbine power-generating systems; improved exploration methods; desalination methods for geothermal fluids; cheaper methods for deep drilling into hot formations; and better models of geothermal reservoirs. (MCW)

17672 HEAT RECOVERY: HOW CAN THE HEAT PIPE HELP? Deyoe, D. P. (Southern California Gas Co., Los Angeles). ASHRAE (Amer. Soc. Heat., Refrig. Air Cond. Eng.) J.; 15: No. 4, 35-38(Apr 1973).

The concept of energy transport by heat pipes is applied to energy conservation. A example of this technology in air conditioning, heating, and ventilating systems is a heat exchanger used in duct systems to transfer thermal energy. The exchanger obviously may be used in many air-to-air heat transfer situations throughout the system (e.g., to recover heat from flue gas exhaust stream). These exchangers are also produced in larger sizes for application to industrial processes. (MCW)

17673 ENERGY: SHORTAGES LOOM, BUT CONSERVATION LAGS. Holden, C. Science; 180: No. 4091, 1155-1158(15 Jun 1973).

Long-range energy conservation policies are needed in order to preserve the environment, but immediate steps are needed until new, clean power sources become available. Legislation and interest are lagging. The steps that could be taken to reduce fuel consumption and make electricity more efficient have been delineated many times: build automobiles that operate on lower horsepower, develop urban mass transit, shift freight from plane and trucks to rails and waterways, insulate buildings, design new buildings for maximum use of heating and cooling systems, set minimum efficiency requirements for power-consuming products, save natural gas for uses other than production of electricity, recycle waste, and change power rates to encourage efficiency. (MCW)

17674 ENERGY POLICY FROM THE FEDERAL STANDPOINT. David, E. E. (Science Advisor to the President, Washington, DC). Chem. Eng. Progr.; 69: No. 6, 22-26(Jun 1973).

The energy policy is a major concern of the Office of Science and Technology. Seven departments of the government involved in research and development in energy are the Atomic Energy Commission, Interior Department, the Environmental Protection Agency, the Commerce Department through the Bureau of Standards, the National Science Foundation, NASA, and the Department of Transportation. A recognized policy involves technological, economic, social, legal, political, environmental, and moral problems. The President's Science and Technology Message to Congress in 1973 is analyzed. Near, medium, and long term challenges are outlined. (MCW)

17675 OVERVIEW OF SUPPLY/DEMAND FOR THE NEXT DECADE. Searl, M. F.; Schurr, S. H. (Resources for the Future, Inc., Washington, DC). Chem. Eng. Progr.; 69: No. 6, 27-34(Jun 1973).

The ability to bring the major new technologies into being quickly enough to make large additions to domestic supply for the period to 1985 is doubtful. It is believed, however, that the U. S. does have the option of increasing domestic production of oil and gas from expanded reserves during this time to help relieve the crisis. Commercially significant production from breeder reactors, from advanced coal gasification techniques, and from shale oil and perhaps coal liquefaction appears possible in the 1985–2000 period. Domestic supply should increase from development of geothermal, solar, and the nuclear fusion options. Technique development should allow the usage of high- and medium-sulfur coal in power plants. Light-water reactors and high-temperature gas-cooled reactors may be strong competitors for the power plant market in the 1985–2000 period. It is suggested that federal energy R&D budget be devoted directly or through industry to work on oil and gas exploration, development, and recovery. (MCW)

17676 CHALLENGES IN PRODUCTION OF FOSSIL FUELS. Hottel, H. C. (Massachusetts Inst. of Tech., Cambridge). Chem. Eng. Progr.; 69: No. 6, 35-39(Jun 1973).

The near-term growth pattern of U. S. energy consumption will not depart significantly from the pattern of the past. This growth is finally catching up with our capacity to supply energy in presently acceptable forms. There is no expectation that nuclear power will contribute more than one-fourth of the total energy needed by 2000 A.D. (counting nuclear-source electrical energy as the equivalent of the thermal energy needed to produce it, at an efficiency of one-third). The half-lives of our factories, machines, and industrial processes and of our mores and customs are great enough that, much as improvement in energy use is to be encouraged, major change in GNP and services produced per unit of energy consumed cannot be expected to occur fast enough to have a major impact in the near term. Our supplies of coal are enormous compared to other fossil resources and supplies of oil shale are less impressive. The suggestion that the energy needed in near term (1985 to 2000) can come from nonfossil fuels only confuses the issue in that it is not feasible yet. Six alternatives are: import large quantities of crude oil and/or oil products and large quantities of liquefied natural gas; encourage more vigorous search for gas and oil, as by changing the federal position on gas price control and on federal land lease; increase the research effort on improved recovery of oil and gas from the ground; increase the efficiency of use of energy; learn how to burn coal cleanly; and convert coal, shale oil, bitumens to clean gas or clean oil. (MCW)

17677 ENVIRONMENTAL CHALLENGES AND NUCLEAR FUELS. Davis, W. K. (Bechtel Power Corp., San Francisco, CA). Chem. Eng. Progr.; 69: No. 6, 48-53(Jun 1973).

Expansions in the nuclear programs will not in themselves solve the energy crisis by 1985 or even 1990, but could have a significant part in alleviating it. Nuclear power must be mainly applied to the generation of electric power and some large-scale industrial heat uses. The supplies of nuclear fuels at reasonable prices must be considered adequate, in view of the availability of breeder technology when needed—that will vastly expand the equivalent energy content of nuclear fuels. It appears that the environmental impact of nuclear power plants will be less than other power plants, except for the higher rejection of heat to cooling water per unit of power produced. The problems due to radioactivity emissions from nuclear power plants are not significant. The long-range storage of high-level radioactivity cannot be considered an unmanageable problem or one with significant cost or environmental impacts. The long-range development of the fusion reactor, along with the breeder reactor, will give unlimited energy resources. The ability to supply all energy needs from nuclear sources will depend on further inventions and developments in the storage and transport of energy (such as automobiles, aircraft, etc.). (MCW)

17678 WORLD ENERGY NEEDS IN RELATION TO ECONOMIC GROWTH AND QUALITY OF LIFE. Felix, F. Energy Int.; 9: No. 7, 22-26(Jul 1972).

The latest trends of growth of use of energy and of gross national product were correlated for selected countries of the world and are presented. An elasticity coefficient is determined by a measure of the ratio of the rate at which GNP grows to the rate at which the use of energy increases. With the presentation of the data from the book "World Markets of Tomorrow" by the author, an attempt was made to dispel some of the misconceptions that have been responsible for the recent concern about the perils from exponential growth of consumption of energy in its partnership with economic growth. Other facets of energy that were discussed include growth, productivity, convenience, social betterment, higher quality of the environment, and for survival with recycling, desalting, and synthetic industries to replenish natural resources. (MCW)

17679 FUNDY TIDAL POWER. Clark, R. H. (Univ. of New Brunswick, Canada). Energy Int.; 9: No. 11, 21-26(Nov 1972).

At the Bay of Fundy the tidal range reaches 53 feet making it

desirable for a tidal power plant. Other qualified locations are the Rance Estuary on the Brittany coast of France; in Alaska there are sites with tidal ranges exceeding 33 feet; in the Gulf of California near the mouth of the Colorado River the tidal range reaches 30; the Severn Estuary in England has a tidal range in excess of 45 feet. Argentina, India, Korea, Australia, and the northern coast of Russia have desirable locations. The power and energy that can be developed at any site depend upon the usable head that varies continuously with the tidal regime and is modified by the fluctuation of basin levels resulting from operation of the plant, the area of the developed basin, the capacity of the sluiceways used to fill or empty the basin, the capacity of generating units, and the method of operation utilized. The installed capacity is fixed by economic considerations rather than by the available flow. The same considerations apply to sluiceway capacity that is selected to allow proper filling and emptying of the basin for optimization of energy production. Studies on the feasibility of a tidal plant at Fundy were made in 1969, and technologically, the renewable source of energy provided by the tides is within reach. (MCW)

17680 SOLAR HEAT UTILIZATION IN RESIDENTIAL HEATING SYSTEMS. Ostad-Hosseini, A. Philadelphia; Univ. of Pennsylvania (1972). 216p. University Microfilms Order No. 73-14,447.

Thesis (Ph.D.).

A performance model of a solar collector was created in order to determine the useful heat that may be obtained from a flat-plate solar collector. The model permits the calculation of the efficiency of a flat-plate solar collector as a function of interplate spacing, incident solar radiation, number of plates, emissivity and absorptivity of the absorber, angle of incidence, and other engineering variables. The computer program can predict the efficiency of solar collector as a function of date, time, location, and orientation of the collector, the thermal and optical properties of glass and absorber plates, and the temperatures of the outside glass plate, and the absorber plate. Weather data can be fed into the computer along with this program to obtain the yearly yield of solar heat. (MCW)

17681 ENERGY CONSERVATION THROUGH EFFECTIVE UTILIZATION. Berg, C. A. (National Bureau of Standards, Washington, DC). Science; 181: No. 4095, 128-138(13 Jul 1973).

The ineffective utilization of energy in buildings and industrial processes constitutes a major component of the energy problems in the United States. Not only could the effectiveness of energy utilization be improved, but such improvement appears to be justifiable economically, especially when the costs of the alternative of expanding the national capacity to supply increasing energy demands are considered. The measures to improve effectiveness of energy utilization are basically technological in nature. However, at present, there does not exist an identifiable technological field concerned with energy conservation through effective utilization. Although techniques for this purpose exist and others can be developed, extant techniques have not been integrated and applied in rational field practice, and there is no disciplinary framework within which further developments might be made. (34 references) (auth)

17682 HYDROGEN: ITS FUTURE ROLE IN THE NATION'S ENERGY ECONOMY. Winsche, W. E.; Hoffman, K. C.; Salzano, F. J. (Brookhaven National Lab., Upton, NY). Science; 180: No. 4093, 1325-1332(29 Jun 1973).

The implementation is feasible for the role of hydrogen in the energy economy. It is shown that hydrogen could be a viable secondary source of energy derived from nuclear power; for the immediate future, hydrogen could be derived from coal. A hydrogen supply system could have greater flexibility and be competitive with a more conventional all-electric delivery system. Technological improvements could make hydrogen as an energy source an economic reality. The systems examined show how hydrogen could serve as a general-purpose fuel for residential and automotive applications, electrical applications of the household via fuel cells, turbines, or conventional total energy systems. The economics and safety factors of hydrogen utilization in energy systems are discussed. 22 references. (MCW)

17683 TOWARD AN ENERGY ETHIC. Gustavson, M. R. (Univ. of California, Livermore). EOS, Trans., Amer. Geophys. Union; 54: No. 7, 676-681(Jul 1973).

Explicit differences in viewpoints that exist regarding the energy crisis are discussed. There are disagreements as to the nature or even the existence of the problem. There are differences in the types of consequences that are of primary concern. There is no commonly accepted and suitable framework within which to resolve many of the fundamental issues. The review gives some insight into the variety of primary concerns that motivate those engaged in the energy dialog, another barrier to productive discussion that often goes unrecognized. The enormous potential impact of decisions about energy is reviewed. A notion is offered as to the nature of the consensual framework that must be constructed as a basis for broadly acceptable decisions on energy policy. It is conjectured that the construction of this framework will require the development of an energy ethic. (MCW)

17684 POWER GENERATION AT THE TOP 100 ELECTRIC COMPANIES. Owens, K. R. Elec. Light Power (Boston); 51: No. 13, 26-35(Jul 1973).

Some large electric power producers made adjustments in 1972 to accommodate the fuel crisis. The wide swings are shown in coal, oil, and gas consumption in a table ranking the top 100 power generating companies, with comparisons for 1971, on heat rates and fuel consumption data. Where natural gas could be bought, the consumption—primarily for use in gas turbines—went up considerably. Where the gas could not be bought, the companies used considerable quantities of oil, the quality of which varied from #2 diesel fuel to heavy crude, causing higher maintenance rates. Peak demand and capability for the 100 companies were also tabulated. The amount of fossil, hydro, gas turbine and diesel, and nuclear power generation in each of the top companies is listed. It is concluded that the ultimate answer to the national energy problem, according to the president's message, is expanded research and development. The essence of the statistics provided on fuel consumption by the electric companies now shows a stable pattern. (MCW)

17685 OIL: THE OMNIPOTENT ENERGY SOURCE. Griedlander, G. D. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 10: No. 7, 26-29(Jul 1973).

Between 1973 and 1985, an adequate petroleum supply will be the hinge or fate for the US economy. In reviewing a brief history of the oil exports of the Arab states in the last few years, it is seen that the US must develop new oil sources, construct refineries within its continental borders, and establish conservation policies that will mitigate the coming crunch. The dependency of countries on the oil exports from the Middle East may be used as a weapon or club, as has been observed in Italy. In the US, since oil will be the predominant energy fuel during the next 12 years (the only fuel capable of meeting our escalating energy requirements), the potentially adverse effects of Middle East manipulation of the oil flow on the balance-of-payments deficit are staggering. A National Petroleum Council summary lists three options; the US could depend upon increased overseas import of oil and gas to meet national requirements but this would impair national security and trigger an awesome deficit in our balance of trade in fuels; through imposed restrictions, the US could reduce the growth in energy consumption and demand more efficient use of energy, impairing the nation's lifestyle and triggering an even larger deficit in its balance of trade in fuels; the US can accelerate the development of its domestic energy resources and this is strongly recommended. (MCW)

17686 ENVIRONMENT, ENERGY, AND THE NEED FOR NEW TECHNOLOGY. Dalal, V. Energy Convers.; 13: No. 3, 85-94 (Jul 1973).

The problem of energy and energy technology is examined from an environmental viewpoint. The energy resource problem is briefly reviewed and the need is shown for a rapid development of newer fossil-fuel technologies such as coal gasification. The various energy technologies are critically examined; those which are popular today (e.g., nuclear water reactors, modified gasoline cars) and new technologies which are in early stages of development (e.g., solar energy, electric cars, coal-gas powered advanced turbines). It is shown that several of the newer technologies have significant advantages over the presently popular technologies. These advantages include higher energy efficiencies and significantly lower environmental degradation. A model of the probable energy consumption patterns in 1990 indicates that the newer technologies, if developed, could have significantly lower resource depletion, air pollution and thermal pollution in 1990 as compared to the extensions of presently popular technologies. The problem of energy has also been viewed from the demand side. It is shown that the growth in demand cannot continue at the present rate without causing serious thermal imbalance over relatively large areas of developed society (e.g., the northeastern U.S., Western Europe). Some of the possible changes in attitude (e.g., more mass transportation, better natural design) that may be necessary to bring about a better balance between man and nature have been briefly discussed. (auth)

17687 NUCLEAR ENERGY AND CIVILIZATION. Gibrat, R. (Societe pour l'Industrie Atomique, Paris). Energ. Nucl. (Paris); 15: No. 1, 7-12(Jan 1973). (In French).

According to a recent Mitre survey, there should be no energy shortage in the world, if new technologies are developed (breeder reactors, fusion, etc.). In the next few decades, nuclear fission energy alone can meet these needs. The most serious problem

involves heat discharges, which could cause climatic changes. (FR)

Information Handling

Refer also to abstracts 15478, 15504, and 17700.

17688 (BNL-17827) UNIQUE ASPECTS OF UTS REAL-TIME DATA ACQUISITION AT BNL. Rogers, P. C.; Kolata, J. J. (Brookhaven National Lab., Upton, N. Y.). [nd]. 11p. (CONF-730540-1). Dep. NTIS $3.00.

From XDS Users' Group International Exchange meeting; Toronto, Canada (30 May 1973).

The UTS System has been used at BNL in a real-time evironment for collection, display, and sorting of nuclear physics data. This is in addition to the usual batch streams and on-line terminal operation. The data acquisition routine consists of a small resident portion which buffers incoming data onto disc and tape and a ghost job which sorts and displays the results every 1.7 seconds. Extensive use is made of the various entries to NEWQ but few other special features of UTS are required. Data rates in excess of 40,000 events per second have been input with no ill effects outside of response degradation for normal users. (auth)

17689 (CEA-N-1616) SYSTEM OF SELECTIVE DISSEMINATION BASED ON NUCLEAR SCIENCE ABSTRACTS. Dirian, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1973. 17p. (In French). Dep. NTIS (U. S. Sales Only) $3.00.

Experience of three years treatment of the NSA tapes for SDI is described from a documentation standpoint. The possibilities offered by some of the peculiarities of the NSA system are pointed out. (FR)

17690 (ORNL-TM-3814) IMPLEMENTATION AND MODIFICATION OF THE CHEMICAL ABSTRACTS SERVICE NAME-MATCH SYSTEM, PHASE I. Hamilton, H. J.; Giles, C. A.; Altom, D. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 49p. Dep. NTIS $4.50.

This report describes program and workflow modifications made to the CAS Name-Match system. A set of utilities designed to support operation of the modified system are briefly described. A glossary of terms and a set of abstracts of the programs in the CAS system are attached to eliminate the necessity for including detailed definitions and program descriptions in the text of the report. (auth)

17691 (ORO-3992-124) ADAPTATION OF THE AIP SEARCHABLE PHYSICS INFORMATION NOTICES FOR USE ON CDC 6000 SERIES COMPUTERS. Parsons, R. G. (Texas Univ., Austin. Center for Particle Theory). Feb. 1972. 18p. (CPT-118). Dep. NTIS $3.00.

An adaptation is made of the machine-readable data base of Physics and Astronomy journal literature "Searchable Physics Information Notices" (SPIN) for CDC 6000 series computers using the information storage and retrieval system "Remote File Management System" (RFMS). (auth)

17692 (SLA-73-5592) LEXICOGRAPHIC CORRELATION OF DOCUMENTS. Burd, W. C.; Morrison, D. R. (Sandia Labs., Albuquerque, N. Mex.; New Mexico Univ., Albuquerque). 1973. 20p. (CONF-730711-1). Dep. NTIS $3.00.

The problem of defining a lexicographic correlation is dealt with, acknowledging that it is at best, a poor substitute for a semantic correlation; but it is a beginning and it is a feasible objective, with a rather modest requirement of computer time and memory. (auth)

17693 (UCLA-10-P-14-109) BOUNDS ON THE NUMBER OF PROCESSORS AND TIME FOR MULTIPROCESSOR OPTIMAL SCHEDULES. Feranadez, E.; Bussell, B. (California Univ., Los Angeles. Dept. of Computer Science). 1972. Contract AT(11-1)-Gen-10. 25p. (CONF-720687-1). Dep. NTIS $3.25.

Two problems of importance for the scheduling of multiprocessing systems composed of identical units are discussed. (1) Given a partially ordered set of computations represented by the vertices of an acyclic-directed graph with their associated execution times, find the minimum number of processors in order to execute them in a time not exceeding the length of the critical path of this graph. (2) Determine the minimum time to process this set of computations when a fixed number of processors is available. A unified formulation for lower bounds on the minimum number of processors and on time is presented. These lower bounds are sharper than previously known values and provide a general framework which gives insight for deriving simplified expressions. A new upper bound on the minimum number of processors is presented, which is sharper than the known bounds. The computational aspects of these bounds are also discussed. (auth)

17694 TUBE SCANNER DATA AQUISITION SYSTEM (24 MAY 1972) (ENGINEERING MATERIALS). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2340).

6 drawings.

Mathematics and Computers

Refer also to abstract 15617.

17695 (AEEW-M-1200) LEAP AND ADDELT, A USERS GUIDE TO TWO COMPLEMENTARY CODES ON THE ICL-470 FOR CALCULATING THE SCATTERING LAW FROM A PHONON FREQUENCY FUNCTION. Butland, A. T. D. (Atomic Energy Establishment, Winfrith (England)). Jun 1973. 40p. Dep. NTIS (U. S. Sales Only) $4.00.

This memo is intended as a users guide to the Harwell codes LEAP and ADDELT as they exist on the ICL-470 at AEE Winfrith. Both codes were written by McLatchie (1962), who has provided part of the information in this memo. LEAP calculates the scattering law from a phonon frequency function, but will only deal with continuous or piece-wise continuous spectra. ADDELT receives a scattering law as input, and adds to it the effect of delta functions in the phonon frequency spectrum. (auth)

17696 (ANL-8040) USAEC COMPUTER PROGRAM SUMMARIES. Numbers 1 through 54. (Argonne National Lab., Ill.). Apr 1973. Contract W-31-109-eng-38. 39p. Dep. NTIS $4.00.

The Argonne Code Center serves as a USAEC information center for computer programs developed and used primarily for the solution of problems in nuclear physics, reactor design, reactor engineering and operation. This report contains summaries of 54 programs, along with KWIC and subject indexes and general information about program storage at the center. (RWR)

17697 (CEA-CONF-2212) AUTOMATIC MEASUREMENTS. Roquefort, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1973. 91p. (In French). Dep. NTIS (U. S. Sales Only) $6.75.

The term "automatic measurements" covers all measurements carried out automatically, generally by electronic methods. The operational procedure and data treatment are controlled by a memory, punched tapes, and small or large computers. Different systems are used according to their purpose: measurement bank, data acquisition, tests, and automatic measurements. The last term refers mainly to complex measurements requiring very precise metrology and relatively complicated calculations on the results. A choice must be made. The composition of a typical system and some information on the connections are given. The results are supplied on a teleprinter, curve plotter, or display system. These systems are of great value in many fields. Finally some practical examples of low- and high-voltage supplies, amplifiers, voltmeters, and analog-digital converters are given. (auth)

17698 (CONF-730812-2) SPARSE AND CROWDED CELLS AND DIRICHLET DISTRIBUTIONS. Sobel, M.; Uppuluri, V. R. R. (Minnesota Univ., Minneapolis; Oak Ridge National Lab., Tenn.). 1972. 10p. Dep. NTIS $3.00.

A multinomial distribution with k cells is given with b cells ($1 \leq b \leq k$) having common cell probability p ($0 < p \leq 1/b$); these are called blue cells. Dual concepts of sparseness and crowdedness are introduced for these b blue cells based on a fixed number n of observations. The (type 1) Dirichlet distribution is used to evaluate the probability laws, the cumulative distribution functions (c.d.f.'s), the moments, the joint probability law and the joint moments of the number S of sparse blue cells and the number C of crowded blue cells. The results are put in the form of moment generating functions. Applications of some of these results are also considered. (auth)

17699 (LA-5219-MS) CDC 7600: FORTRAN OPTIMIZING TECHNIQUES. McGirt, F.; Melendez, K. J.; Rudsinski, L. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-46. 7p. Dep. NTIS $4.00.

Operations and techniques are described that the FORTRAN programmer can perform manually at the source-code level to improve object-code performance. (auth)

17700 (MLM-2011) IMPROVED EDITING AND COMPILING WITH THE DIGITAL PDP-8/I COMPUTER. Foster, K. W. (Mound Lab., Miamisburg, Ohio). 26 Jul 1973. Contract AT(33-1)-Gen-53. 34p. Dep. NTIS $4.00.

A number of improvements were made to the Symbolic Editor and the PAL III compiler to reduce the operator difficulty in using these programs, to reduce the time required to edit and compile a binary program, and to reduce the probability of errors. Two editing and compiling systems were developed

from these improvements; one is a single-program editor-compiler combination, entitled PALEDCO II, in which the ASCII source file is completely self-contained; the other system has an editor and a compiler as separate programs which incorporate all the improvements in PALEDCO II with Tri-Data Cartrifile storage of the ASCII source file. The two programs comprising this second system are entitled Cartrifile Editor and Cartrifile PAL III. The major changes to Editor and PAL III are discussed in detail, and operating instructions and flow charts are given for the two systems in appendices. The appendices are set up in operating manual form for ease in using the system. (auth)

17701 (RISO-M-1624) USE OF THE DIGITAL PLOTTER IN ALGOL PROGRAMS ON THE B 6700. Voss, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1973. 19p. Dep. NTIS (U. S. Sales Only) $3.00.

This is a Users Guide for utilization of the Digital Plotter in Algol Programs on the B 6700. The items described are: (1) The plotter-administration ADM4PLOT, into which the users program must be imbedded. The two parts of the administration exist (as SA/142/PLOTSTART and SA/142/PLOTSLUT) in the SA library of the B 6700. (2) The routines given in the list below. The routines PLOTSTRING and PLOTMARK form part of ADM4PLOT. The others are found as separate entities in the SA library; their names in the library are given. (auth)

17702 (SLA-73-79) SLADE D: A COMPUTER PROGRAM FOR THE DYNAMIC ANALYSIS OF THIN SHELLS. Key, S. W.; Beisinger, Z. E. (Sandia Labs., Albuquerque, N. Mex.). Jan 1973. 155p. Dep. NTIS $3.00.

Presented is a finite-element-method FORTRAN program designed for the dynamic analysis of thin shells. A doubly curved, arbitrary quadrilateral element is utilized. The element is based on a minimum potential energy principle for thin shells. A simple central difference time integration scheme together with a diagonal mass matrix is used to compute the transient dynamic response. Since the majority of aerospace structures are based on shells of revolution, the program is designed specifically for a shell the reference surface of which is a portion of an axisymmetric surface. The program allows up to five separate layers and up to five separate elastic anisotropic materials with temperature-dependent properties. The program handles variable thickness shells and allows thickness discontinuities along element boundaries. It provides for both normal and tangential surface loads and for temperature changes through the thickness as well as varying temperatures over the reference surface. Over any portion of the boundary, a choice of thirteen separate boundary conditions is available. To ease data preparation, simple but effective generation schemes are built into the program. The program computes dynamic deformations, velocities, stresses, and stress resultants occurring in the shell. Since it is designed for use by a large number of people, it contains error checks wherever possible and, except where needed for efficiency, very straightforward logic. The FORTRAN used is a low-level variety which aids in conversion from one computing facility to another. In its current form, it will accept up to 650 elements and 700 nodal points and requires a $49{,}000_{10}$-word core. The program uses a singly dimensioned storage array for the total stiffness matrix, mass matrix, and load vector. If a given problem fits within the limits of this storage array, the program functions as an in-core program. If additional storage is required, the program seeks on-line auxiliary storage which must be randomly accessible. (auth)

17703 (SLA-73-334) CDC 6600 ROUTINES FOR SOME CUMULATIVE, MULTIVARIATE DISTRIBUTION FUNCTIONS. Amos, D. E.; Daniel, S. L. (Sandia Labs., Albuquerque, N. Mex.). Mar 1973. 66p. Dep. NTIS $5.50.

A listing of some multivariate distribution functions, their calling sequences, and programs are presented with appropriate comments concerning the implementation of published references. These include the bivariate normal, a bivariate t distribution, a special multivariate t distribution ($\rho_{ij} = \rho$, $i \neq j$ and $T_i \leq t$, $1 \leq i \leq n$) and a multivariate F distribution. (auth)

17704 (SLA-73-584) SANDIA PANEL LANGUAGE. Thompson, R. E. (Sandia Labs., Albuquerque, N. Mex.). May 1973. 43p. Dep. NTIS $4.25.

A programming language for defining the geometry of electronic chassis panels is presented. The language has powerful computational capabilities similar to common mathmatical languages like Fortran. (auth)

17705 (UCID-16187) FLYER CODE, A LUMINESCENCE DATA PROCESSING CODE IN LRLTRAN FOR THE CDC-6600. Haugen, G. R. (California Univ., Livermore. Lawrence Livermore Lab.). 6 Feb 1973. Contract W-7405-eng-48. 62p. Dep. NTIS $5.25.

This revised user's manual describes the method of data processing used by the FLYER code and the options available for data presentation. This code is written in LRLTRAN for the CDC-6600 computers under control of the monitor 402, and will batch-process the data taken by the PDP-7 controlled luminescence spectrometer system. The information can be acquired in either 2-dimensional or 3-dimensional arrays and displayed either as 2-dimensional absorption, emission, excitation or kinetic data in tabular and/or graphical form, or as 3-dimensional fluorescence or phosphorescence data portrayed in tabular form and/or plotted as contour maps and isometric views. It is possible to portray the data as its first derivative in any of the forementioned modes. Other options allowed by the code are: leaving the data uncorrected, smoothing the data, correcting the data for instrumental response, and for converting the data to energy coordinates. (auth)

17706 (UCRL-74758) COMPUTER CENTER PLANNING. Masson, V. W. (California Univ., Livermore. Lawrence Livermore Lab.). [nd]. 12p. (CONF-730336-1). Dep. NTIS $3.00.

The area of computer center planning is of considerable current interest; how it is practiced and implemented at Lawrence Livermore Laboratory with the computer center is the basis for this discussion. Included is the planning philosophy as well as practical applications, with some examples as they relate to user needs and their satisfaction in terms of hardware, software, and facilities. (auth)

17707 (WASH-1245-1) STANDARD FOR FIRE PROTECTION OF AEC ELECTRONIC COMPUTER/DATA PROCESSING SYSTEMS. Weintraub, A. A.; O'Connor, T. P. (Division of Operational Safety (AEC), Washington, D. C.). Jul 1973. 42p. GPO $0.45.

This standard applies to all essential electronic computer data processing equipment as well as the storage facilities, associated utilities, and air conditioning systems. Electronic computer/data processing equipment consists of an analog or digital computer, together with input, output, memory, and other peripheral equipment. (MOW)

Miscellaneous

17708 (AE-473) SELECTIVE-STEP SCANNING: A SIMPLE MEANS OF AUTOMATING THE PHILIPS DIFFRACTOMETER FOR STUDIES OF LINE PROFILES AND RESIDUAL STRESS. Brown, A.; Lindh, S. A. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Apr 1973. 36p. Dep. NTIS (U.S. Sales Only) $4.00.

An electronic control unit has been devised for steering the Philips X-ray powder diffractometer in the selective-step scan mode. This type of scan is used for recording diffraction-line profiles in connection with studies of crystallite size and microstrain distribution and for evaluating peak positions in measurements of cell parameter and residual stress. (WHK)

17709 (AEC-tr-7435) PRESERVATION OF STEAM BOILERS. Schiffers, A. Translated from Mitt. Ver. Grosskesselbesitzer; No. 83, 104-107(1963). 6p. Dep. NTIS.

The use of hydrazine for preservation of steam boilers is discussed. Some chemical reactions involved are discussed, along with a corrosion test procedure. (MOW)

17710 (ANL-Trans-945) TOXIC ACTION OF 2,4-D, A WEED KILLER, ON THE EMBRYONIC DEVELOPMENT AND FERTILITY OF GAME BIRDS. Lutz-Ostertag, Y.; Lutz, H. Translated from Compt. Rend., Ser. D; 271: 2418-2421(1970). 11p. Dep. NTIS $3.00.

17711 (BDX-613-561(Rev.)) NONDESTRUCTIVE TESTING OF PERCUSSIVE ARC WELDS. Cox, K. O. (Bendix Corp., Kansas City, MO). Jul 1973. Contract AT(29-1)-613. 57p. Dep. NTIS $5.00.

Of the seven nondestructive weld evaluation techniques studied at Bendix Kansas City, ultrasonic testing has proven most effective for determining the quality of percussive arc welded electrical connectors. (auth)

17712 (BDX-613-662) ELECTRICAL TERMINATIONS: WELDED, BRAZED, AND BONDED, FY72-3. Quarterly Report. Stittsworth, D. E. (Bendix Corp., Kansas City, MO). Mar 1973. Contract AT(29-1)-613. 29p. Dep. NTIS $3.50.

Design and fabrication activities are in process on an ac pulse-arc weld system, a pulse-arc monitor, a percussive-arc actuator, and a constant power control for ac resistance welders. Material evaluations were performed on copper lead frame terminations to nickel or copper clad printed circuit boards and a process is being evaluated to detect the presence of cuprous oxide within small diameter copper wire used on pulse-arc weld applications. (auth)

17713 (BDX-613-708(Rev.)) OPTIMIZING MINIATURE CYLINDRICAL PIECEPART MACHINING CAPABILITIES. Robb, J. M. (Bendix Corp., Kansas City, MO). Aug 1973. Contract AT(29-1)-613. 20p. Dep. NTIS $3.00.

Automatic screw machines are used to manufacture large quantities of piece parts for some assemblies. These parts are characterized by hard, abrasive, corrosion-resistant alloy materials, and by miniature size with such close tolerance requirements as 0.0263 ± 0.00020 and 0.04065 ± 0.00015 inch (0.668 ± 0.005 and 1.031 ± 0.0038 mm). Optimization of Bendix's Swiss machine tooling and processing techniques was needed to improve the efficiency in producing these parts. A more consistent automatic screw machine capability has resulted. Improvements in the stock preparation procedures for centerless grinding and heat treatment operations, use of improved cutting tool materials, and the selection of optimum tool positions and sequence of cuts have resulted in a 50-percent reduction in the process standard deviation. Improvements in the cutting tools have resulted in a 300% increase in yield of parts per tool. Techniques developed and experience gained through this work have been incorporated into existing screw machine processes and will be used in future machining of parts related to screw machine processes. (auth)

17714 (BDX-613-904) LINEAR TRANSDUCER TIP PRESSURE CHECKER. Cooper, E. B. (Bendix Corp., Kansas City, Mo.). Jun 1973. Contract AT(29-1)-613. 19p. Dep. NTIS $3.00.

An instrument was developed which checks the tip pressure of linear transducers without requiring the removal of the transducers from gage housings. The device has a range of 0 to 50 grams and a repeatability (two sigma confidence) of better than ±0.75 gram when calibrated before each use. (auth)

17715 (BNL-17970) INTERSPECIFIC PLANT HYBRIDIZATION AND THE GENETICS OF MORPHOGENESIS. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). 1973. 21p. (CONF-730643-1). Dep. NTIS $3.25.

From symposium on basic mechanisms in plant morphogenesis: Upton, New York, USA (4 Jun 1973).

17716 (BNL-18004) REGULATION OF CELL DIVISION IN HIGHER PLANTS. Van't Hof, J. (Brookhaven National Lab., Upton, N. Y.). 1973. 17p. (CONF-730643-3). Dep. NTIS $3.00.

From symposium on basic mechanisms in plant morphogenesis; Upton, New York, USA (4 Jun 1973).

17717 (BNWL-1750(Pt. 1), pp 71-77) INDUCTION OF EXOCELLULAR PROTEASES FROM NEUROSPORA CRASSA. Drucker, H. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

17718 (BNWL-1750(Pt. 1), pp 77) CONTROL OF ENZYME INDUCTION AT THE MEMBRANE LEVEL IN NEUROSPORA CRASSA. Wiley, W. R.; Drucker, H. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

17719 (BNWL-1750(Pt. 1), pp 78-81) STUDIES ON NUTRILITE TRANSPORT IN NEUROSPORA CRASSA. Wiley, W. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

17720 (BNWL-1750(Pt. 1), pp 81-82) STUDIES ON TRYPTOPHAN METABOLISM IN NEUROSPORA CRASSA. Turner, J. R. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

17721 (BNWL-1750(Pt. 1), pp 82-83) CHANGES IN THE SPECIFICITY OF BACILLUS THERMOLYSIN AS A FUNCTION OF CALCIUM CONCENTRATION. Drucker, H.; Unger, M. Apr 1973.

In Pacific Northwest Laboratory annual report for 1972.

17722 (BNWL-SA-4720) DEVELOPMENT OF A WATER TREATMENT PLANT OPERATION MANUAL USING AN ALGORITHMIC APPROACH. Counts, C. A. (Battelle Pacific Northwest Labs., Richland, Wash.). 1972. 10p. (CONF-730545-1). Dep. NTIS $3.00.

An orderly procedure for solving problems during the operation or management of a water treatment plant using an algorithmic approach or flow prescription is presented. The flow prescription approach enables the inexperienced operator to perform immediately and with accuracy the operation of the equipment and processes in question, and it does so without expensive and time consuming training techniques. The operator will soon learn the principles and reasons for the actions taken in the flow prescription. (MCW)

17723 (CALT-822-52) ANOMALOUS ELECTRICAL RESISTIVITIES AND MAGNETIC PROPERTIES OF AMORPHOUS METALLIC ALLOYS. Hasegawa, R. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jun 1973. Contract AT(04-3)-822. 74p. Dep. NTIS $5.75.

Results of electrical resistivity, magnetoresistivity and magnetization measurements are presented for the temperature range 1.3 to 300°K on amorphous Ni–Pd–P alloys in which Ni is replaced by Fe. In this pseudobinary system, magnetism of the alloys changes from Pauli-like paramagnetism in Ni–Pd–P to well-defined ferromagnetism in Fe–Pd–P. The dilute alloys containing less than 10 at. % Fe can be classified as amorphous Kondo alloys. It is shown that resistivity and magnetic anomalies can be explained by assuming the existence of single and pair iron impurity states, the former having a Kondo temperature of about 14°K and the latter less than 1°K. (LMT)

17724 (CEA-CONF-2254) OVERHAUSER EFFECT AND EXCITON MOTION IN A SALT OF TCNQ. Marticorena, B.; Nechtschein, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 7p. (CONF-720810-2). Dep. NTIS (U. S. Sales Only) $3.00.

From 17th congress ampere-nuclear magnetic resonance and related phenomena; Turku, Finland (21 Aug 1972).

Observations of a positive Overhauser effect (enhancement of NMR signal) on a single crystal of $(\phi_3AsCH_3)^+(TCNQ)_2^-$ [TCNQ = tetracyanoquinodimethane] are reported which provide direct proof of exciton motion. (DLC)

17725 (CEA-CONF-2255) LOW-FREQUENCY BEHAVIOR OF THE SPIN-CORRELATION SPECTRUM IN A REAL ONE-DIMENSIONAL SYSTEM. Boucher, J. P.; Ferrieu, F.; Nechtschein, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 7p. (CONF-720810-3). Dep. NTIS (U. S. Sales Only) $3.00.

From 17th congress ampere-nuclear magnetic resonance and related phenomena; Turku, Finland (21 Aug 1972).

The low-frequency behavior was studied using magnetic resonance in TANOL (tetramethyl-2,2,6,6-piperidinol-4, oxyl-1). Experimental and theoretical results are expressed as values of the "cut-off" parameter ω_x/ω_c. (DLC)

17726 (CEA-N-1639) CRITICAL FLOW RATES. Reocreux, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 2 May 1973. 34p. (In French). Dep. NTIS (U. S. Sales Only) $3.75.

Experimental and theoretical studies of critical flow rates in two-phase flows demonstrated that the fundamental problem to be resolved is that of determining the expression for the transfer terms. (FR)

17727 (CEA-N-1641) PRESSURE DROP AND INSTABILITIES IN TWO-PHASE GAS–LIQUID FLOWS. Fabrega, S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb 1973. 59p. (In French). Dep. NTIS (U.S. Sales Only) $5.00.

The methods used to predict the pressure drop occurring in two-phase flow are exposed. A summary is given of the various causes of flow instability linked to the phenomenon determining this pressure drop. (FR)

17728 (CEA-N-1642) HEAT TRANSFER IN TWO-PHASE LIQUID–GAS FLOWS. Semeria, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb 1973. 75p. (In French). Dep NTIS (U. S. Sales Only) $5.75.

Heat transfer in liquid–gas flows is reviewed, particular attention being given to problems involving phase changes. The following points are considered: interphase thermal resistance, interphase heat exchange without mass transfer, transfer between a wall and a two-phase fluid, nucleation, pool boiling, boiling in heated tubes, and condensation. (FR)

17729 (CEA-R-4371) DYNAMIC POLARIZATION IN PARAMAGNETIC SOLIDS AND MICROSCOPIC CORRELATION FUNCTIONS. Boucher, J. P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1973. 143p. (In French). Dep. NTIS (U. S. Sales Only) $9.25.

Thesis. Submitted to Universite Scientifique et Medicale de Grenoble (France).

The different effects of dynamic nuclear polarization in paramagnetic solids are described by means of a single thermodynamic formalism. In the case of large exchange interactions, the Overhauser effect correlated with nuclear relaxation time measurements can provide a way of studying correlation functions between electronic spins. This method is used to study the low-frequency behavior of the microscopic spectral density,

which should diverge as $\omega \rightarrow 0$, in the case of a linear exchange chain. (auth)

17730 (CEA-R-4387) STUDY OF VACANCY ELIMINATION IN CHEMICAL DIFFUSION AND ELECTROMIGRATION. Monty, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 124p. (In French). Dep. NTIS (U. S. Sales Only) $8.25.

Thesis. Submitted to Paris Univ., Orsay (France).

An attempt was made to determine the vacancy elimination mechanisms in diffusion phenomena where important nonconservative vacancy fluxes are induced. The validity of the phenomenological equations used to describe the diffusion and the associated Kirkendall effect in the gold–silver system were studied. A discrepancy was found between the results of theory and experiment due to the presence of macroscopic cavities in the couples. It is shown that the physical description of the phenomenon remained correct under pressure, but that the chemical diffusion could give rise to a "lateral Kirkendall effect". Some electron microscopic observations in Au–Ag chemical diffusion zones and in pure metals revealed both an electric field and a temperature gradient where applied. Supersaturations were found to be very small ($\simeq 10^{-2}$). Observed cavities were thought to be due to a precipitation of gases instead of vacancies. When they are large ehough ($\simeq$ 1000 A), these bubbles can act as nuclei for the cavities currently observed by optical microscopy. (tr-auth)

17731 (CEA-R-4398) CONTRIBUTION TO THE VIBRATORY STUDY OF THE CYLINDRICAL THIN SHELLS. Boulegue, D.; Samson, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 73p. (In French). Dep. NTIS (U. S. Sales Only) $5.75.

The search for ways giving the elastic characteristics of special materials constituting some thin cylindrical envelopes leads one to the adoption of a free–free vibratory method which has the double advantage of being nondestructive and simple to use. (MOW)

17732 (CEA-R-4426) STUDY OF UNDERGROUND CAVITIES. Mandel, J. (Commissariat a l'Energie Atomique, Vaujours (France). Centre d'Etudes). Jun 1973. 151p. (In French). Dep. NTIS (U.S. Sales Only) $9.75.

The stability of a cylindrical or spherical cavity in a homogeneous soil under the actions of the gravity and an internal pressure is studied. In the first part, in order to avoid any confusion, some fundamental elements for the constitutive laws of rocks and soils are recalled. The second part is reserved for a systematic study of the cylindrical cavity. Different cases are considered: the cavity in an elastic medium (small displacements); the cavity in an elastoplastic medium (small displacements); the cavity in a rigid-plastic medium in the frame of the limit load theory (small displacements); the cavity in an elastoplastic medium (large displacements). The third part treats of the particular case of the spherical cavity at great depths in an elastoplastic medium (large displacements). Some parameters that allow one to foresee the stability of the cavity are characterized. (auth)

17733 (CEA-R-4442) TURBULENT CONDUCTIVITY IN A FLOW BETWEEN TWO PLANE PARALLEL WALLS IN A REGIME ESTABLISHED WITH A TRANSVERSE VELOCITY GRADIENT. Auxilien, J. M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1973. 124p. (In French). Dep. NTIS (U.S. Sales Only) $8.25.

Thesis. Submitted to Paris Univ. (France).

Turbulent heat flow was investigated, a filament source being exposed to a planar flow under ambient conditions. A straight section formed from two separate parts having very different sizes was used to obtain the transverse velocity gradient in the channel. The experimental data concern flows having Reynold's numbers lying between 180,000 and 810,000. The turbulence laws established from the Taylor model are confirmed. The anisotropy ratio of the thermal conductivity coefficients was defined and calculated from studies of the diffusion perpendicular and parallel to the isovelocities in the central region of the planar channel. A qualitative interpretation of the experimental observations was made in terms of the secondary currents; the degree to which these currents can facilitate energy transfers in the finned exchangers is stated. (5 tables, 50 figures, 30 references). (auth)

17734 (CEA-R-4461) ATMOSPHERIC AEROSOL VARIATIONS AS A FUNCTION OF ENVIRONMENT FEATURES. Dupoux, N. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1973. 38p. (In French). Dep. NTIS (U.S. Sales Only) $4.00.

The effects of some local parameters on the variations of aerosol atmospheric concentration, mean radius, and electrical charge are studied. The importance of pollution has an effect on the concentration level and on its development rate. The diurnal increasing of aerosol atmospheric concentration and decreasing of mean radius and electrical charge show that very fine neutral particles are formed during the day in air. It seems that there is a relation between this phenomenon and the existence at the same time of SO_2 in air and solar radiation. Other atmospheric phenomena (rain, fog, temperature inversion, no wind) because of their action that allows accumulation, or on the contrary dispersion of pollutants, have also an influence on the aerosol atmospheric features. (auth)

17735 (CONF-721227-1) SUITABILITY INDICES FOR EVALUATING HIGHWAY ROUTE ALTERNATIVES. Shugart, H. H. Jr. (Oak Ridge National Lab., Tenn.). [nd]. 21p. Dep. NTIS $3.25.

17736 (CONF-730505-7) MODELING THE EFFECTS OF TEMPERATURE CHANGES ON THE ECOLOGY OF RANA PIPIENS AND THAMNOPHIS SIRTALIS. Porter, W. P.; Tracy, C. R. (Wisconsin Univ., Madison). May 1973. 27p. Dep. NTIS $3.50.

From thermal ecology symposium; Aiken, South Carolina, USA (3 May 1973).

17737 (CONF-730547-1) IDENTIFICATION OF N-NITROSO COMPOUNDS BY MASS SPECTROMETRY. Lijinsky, W.; Rainey, W. T.; Christie, W. H. (Oak Ridge National Lab., Tenn.). [nd]. 5p. Dep. NTIS $3.00.

From American Society for mass spectrometry meeting; San Francisco, California, USA (20 May 1973).

17738 (CONF-730623-2) ULTRASTRUCTURE OF ACTIVE EUKARYOTIC GENOMES. Hamkalo, B. A.; Miller, O. L. Jr.; Bakken, A. H. (Oak Ridge National Lab., Tenn.; Yale Univ., New Haven, Conn. (USA). Dept. of Biology). 1973. 16p. Dep. NTIS $3.00.

From symposium on quantitative biology; Cold Spring Harbor, New York, USA (1 Jun 1973).

17739 (CONF-730633-1) MEGAKARYOCYTOPOIESIS AND ITS RESPONSE TO STIMULATION AND SUPPRESSION. Odell, T. T. Jr. (Oak Ridge National Lab., Tenn.). 1971. 21p. Dep. NTIS $3.25.

From conference on platelets production, function, ultrastructure, transfusion and storage; Boston, Massachusetts, USA (7 Jun 1973.

17740 (CONF-730634-1) CRITICAL EVALUATION OF PROTEIN CRYSTALLOGRAPHIC RESULTS. Johnson, C. K. (Oak Ridge National Lab., Tenn.). 1973. 12p. Dep. NTIS $3.00.

From national research council meeting; Hanover, New Hampshire, USA (24 Jun 1973).

17741 (CONF-730639-1) REGULATION OF GENE EXPRESSION AND VIRAL NEOPLASIA. Kenney, F. T.; Lee, K. L.; Ihle, J. N. (Oak Ridge National Lab., Tenn.). 1973. 16p. Dep. NTIS $3.00.

From symposium on control processes in neoplasia; Omaha, Nebraska (11 Jun 1973).

17742 (CONF-730644-1) POSITION PAPER: MULTICOMPONENT ANALYSIS. Anderson, N. G. (Oak Ridge National Lab., Tenn.). [nd]. 10p. Dep. NTIS $3.00.

From conference on analysis of multicomponent mixtures and their application to health related problems; Washington, District of Columbia, USA (11 Jun 1973).

17743 (COO-841-28) DIFFUSION STUDIES IN LIQUID METALS. Hsieh, M.; Swalin, R. A. (Minnesota Univ., Minneapolis. Inst. of Tech.). Apr 1973. 50p. Dep. NTIS $4.50.

Self-diffusion measurements using tracers were carried out in liquid K and Rb at 1 atm, varying pressure up to 3450 bar, constant volume, and temperatures from 337 o 867°K. Equations were derived for self-diffusion coefficients, and activation volumes were estimated. (DLC)

17744 (COO-1222-57) EFFECT OF AN ELECTRIC FIELD ON THE GAS-CHROMATOGRAPHIC PROPERTIES OF CHOLESTERIC LIQUID-CRYSTAL STATIONARY PHASES. Taylor, P. J.; Ntukogu, A. O.; Metcalf, S. S.; Rogers, L. B. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). 1972. Contract AT(11-1)-1222. 34p. Dep. NTIS $3.75.

Gas-chromatographic properties were determined using a homologous series of carboxylic acid esters of cholesterol as stationary phases and several homologous series of organic species, having different functional groups, as volatile solutes. In general, the capacity ratios for the various solutes increased upon application of an electric field. On a relative basis, the change with potential was larger for smaller capacity ratios, for larger acyl chain length of the liquid crystal, and for a larger carrier-gas flow rate. (auth)

17745 (COO-1332-60) WINTER ACTIVITY OF STRIPED SKUNKS (MEPHITIS MEPHITIS) IN EAST-CENTRAL MINNESOTA. Sunquist, M. E. 1972. 31p. Dep. NTIS $3.75.

17746 (COO-1332-70) SPRING DRUMMING ACTIVITY AND SPACE USE OF RUFFED GROUSE. Archibald, H. L. (Minnesota Univ., St. Paul). Mar 1973. 183p. Dep. NTIS $11.25.
Thesis.

17747 (COO-1332-90) ECOLOGY OF BARRED OWLS AS DETERMINED BY AN AUTOMATIC RADIO-TRACKING SYSTEM. Nicholls, T. H. (Minnesota Univ., St. Paul). Aug 1973. 205p. Dep. NTIS $12.25.
Thesis.

17748 (COO-1332-93) COMMUNICATION IN RED FOX DYADS: A COMPUTER SIMULATION STUDY. Montgomery, G. G. (Minnesota Univ., Minneapolis). Jun 1973. Contract AT(11-1)-1332. 140p. Dep. NTIS $9.00.
Thesis.

17749 (COO-2003-18) LIMNOLOGICAL SURVEY OF LAKES MICHIGAN, SUPERIOR, HURON, AND ERIE. Publication No. 17. Schelske, C. L.; Roth, J. C. (Michigan Univ., Ann Arbor. Great Lakes Research Div.). 1973. Contract AT(11-1)-2003. 113p. Dep. NTIS $7.75.

17750 (COO-2164-7) ENERGY EXCHANGE WITHIN ECOSYSTEMS. Second Annual Technical Progress Report, September 1, 1972–August 31, 1973. Gates, D. M. (Michigan Univ., Ann Arbor (USA). Dept. of Botany). 13 Jun 1973. Contract AT(11-1)-2164. 24p. Dep. NTIS $3.25.

17751 (COO-3010-10) CHARACTERIZATION OF BIOLOGICAL MEMBRANES BY PHYSICAL CHEMICAL METHODS. Progress Report, July 1, 1972–May 30, 1973. Solomon, A. K. (Harvard Univ., Boston, Mass.). 1973. Contract AT(11-1)-3010. 8p. Dep. NTIS $3.00.

17752 (COO-3151-17) HYDROSTATIC PRESSURE STUDIES OF MAGNETIC MODES IN THE FAR INFRARED. Johnson, K. C.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Apr 1973. Contract AT(11-1)-3151. 63p. Dep. NTIS $5.25.
Measurement of the frequency shifts of far-infrared active magnetic modes as a function of applied hydrostatic pressure permitted determination of the variation of the superexchange interaction with interionic spacing in MnO, MnF_2, and MnF_2: Fe^{2+}. In the pure crystals the antiferromagnetic resonance was used as the probe of the exchange interaction, while in MnF_2: Fe^{2+} observation of a localized magnetic impurity mode above the host spin wave band allowed the impurity–host exchange to be monitored. (DLC)

17753 (COO-3151-22) INFRARED WINDOWS FOR USE AT LOW TEMPERATURES. Shotts, W. J.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Apr 1973. Contract AT(11-1)-3151. 8p. Dep. NTIS $3.00.
Vacuum tight mounts for polyethylene and germanium infrared windows operating at 77 and 1.2°K, respectively, are described. (auth)

17754 (COO-3151-23) HYDROSTATIC PRESSURE DEPENDENCE OF THE KBr U-CENTER SIDE BANDS. Shotts, W. J.; Sievers, A. J. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Apr 1973. Contract AT(11-1)-3151. 9p. Dep. NTIS $3.00.
Hydrostatic pressure measurements on the KBr U-center Stokes side bands are reported at 40.8°K for pressures up to 5 kbar. The Grüneisen constant for the phonons near the [0.6, 0.6, 0] saddle point is calculated to be 1.93 ± 0.1 from these measurements. (auth)

17755 (COO-3162-14) PIGMENT CONTENT AND MOLAR EXTINCTION COEFFICIENTS OF PHOTOCHEMICAL REACTION CENTERS FROM RHODOPSEUDOMONAS SPHEROIDES. Straley, S. C.; Parson, W. W.; Mauzerall, D. C.; Clayton, R. K. (Cornell Univ., Ithaca, N. Y. Div. of Biological Sciences; Washington Univ., Seattle (USA). Dept. of Biochemistry; Rockefeller Univ., New York; Cornell Univ., Ithaca, N. Y.). 1972. Contract AT(11-1)-3162. 39p. Dep. NTIS $4.00.

17756 (COO-3162-16) STUDIES OF PHOTOSYNTHETIC ENERGY CONVERSION. Annual Progress Report for the Period September 1, 1972–August 31, 1973. Clayton, R. K. (Cornell Univ., Ithaca, N. Y.). [nd] Contract AT(11-1)-3162. 12p. Dep. NTIS $3.00.

17757 (COO-3400-16) GLUCOSE, MILK PRODUCTION, AND KETOSIS. Kronfeld, D. S. (Pennsylvania Univ., Kennett Square. School of Veterinary Medicine). 1972. 8p. Dep. NTIS $3.00.

17758 (COO-3429-9) ELECTRONIC SPECIFIC HEATS OF ORDERED AND DISORDERED $FePd_3$. Bechman, C. A.; Wallace, W. E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). 1973. Contract AT(11-1)-3429. 10p. Dep. NTIS $3.00.
The electronic specific heat coefficients (γ) of ordered and disordered $FePd_3$ were measured as part of an effort to understand the enhanced hydrogen solubility in the ordered material. For disordered $FePd_3$, γ is higher by 36%, whereas its Debye characteristic temperature (θ_D) is lower by 4%. The hydrogen solubility does not show a positive correlation with the density of states at the Fermi level. (auth)

17759 (EDFB-IBP-72-12) MODEL OF SEASONAL CHANGES IN TOTAL NITROGEN CONCENTRATION IN THE LAKE WINGRA WATER COLUMN. Dettmann, E. H. (Oak Ridge National Lab., Tenn.). May 1973. Contract W-7405-eng-26. 35p. Dep. NTIS $4.00.
The model utilizes available data on land–water exchanges of nitrogen and in-lake transformations to simulate seasonal changes in the total nitrogen content of the Lake Wingra water column. Model response to parameter changes is explored to provide insight into the roles of various mechanisms in controlling the nitrogen concentration. Sedimentation loss and remineralization of sediment nitrogen appear to play a dominant role in determining the seasonal concentration changes, while land–water interactions are important primarily in maintaining the water column nitrogen pool against losses. (auth)

17760 (EDFB-IBP-73-5) EASTERN DECIDUOUS FOREST BIOME, US–IBP. Progress Report, 1971–1972. Burgess, R. L.; Kern, L. H. (eds.) (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 332p. Dep. NTIS $18.75.
This is a summarizing report of the research and administrative activities for the Eastern Deciduous Forest Biome during the period September 1, 1971, through August 31, 1972. A major portion of the research has been concentrated at five intensive research sites: Coweeta, a terrestrial and land/water interaction site at the Coweeta Hydrologic Laboratory of the USDA, Forest Service, located at Franklin, North Carolina; Oak Ridge, a terrestrial and land/water interaction site on the U.S. AEC reservation at Oak Ridge, Tennessee; Triangle, a terrestrial site supporting a managed loblolly pine plantation near Saxapahaw, North Carolina; Lake George, a long, narrow, deep oligotrophic lake in east central New York; and Lake Wingra, a small shallow eutrophic lake lying within the limits of the city of Madison, Wisconsin. Each of the research sites is reported as an entity, but it must be remembered that these pages are stringently edited summaries, and much of the integration among and between sites and investigators may not be immediately apparent. Following the site reports are a series of ecosystem process reports that attempt to integrate work in similar areas across the Biome. Finally, Analysis and Modeling, Biome and Regional Analysis, and the Biome Information Center are presented in separate sections, although again, aspects of these subprograms permeate much of the site program work and interact closely with many of the process research projects. (LMT)

17761 (EUR-5004) ENVIRONMENTAL HEALTH ASPECTS OF LEAD. Proceedings of International Symposium, Amsterdam, October 2–6, 1972. (European Communities, Luxembourg. Commission). May 1973. 1116 p. (In Several Languages). (CONF-721094--). EUR B.Fr. 1500-.
Approximately 100 papers along with discussions after many of the papers are included. Also, a lengthy round-table discussion of an 8-member panel is included on "Evaluation of Current Data to Assess the Health Hazards of Lead." The symposium was jointly organized by the Commission of the European Communities and the United States Environmental Protection Agency. (LMT)

17762 (FMI-1000-433) BIOCHEMISTRY OF THE INTERACTION OF BOVINE FACTORS XIa AND IX. Lundblad, R. L.; Kingdon, H. S. (North Carolina Univ., Chapel Hill; Chicago Univ., Ill.; Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 34p. (CONF-730127-1). Dep. NTIS $3.75.
From 21st annual symposium on blood; Detroit, Michigan (18 Jan 1973).

17763 (HW-84442) CREEP RESISTANCE OF PLATINUM AND PLATINUM ALLOYS AT 1200 C. Carter, J. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 14 Oct 1964. 15p. Dep. NTIS $3.00.
A literature search was made to collect data on high temperature creep properties of Pt and some of its alloys; most of the data concerns stress-rupture properties, and have to be extrapolated for creep. From results given on pure Pt and on Pt alloys with 5 and 10% Rh, it appears the extrapolation of creep and stress-rupture curves tends to give rather optimistic values for the allowable stress. (MCW)

17764 (IC-72/1) PHONON-INDUCED QUADRUPOLE POTENTIAL IN DIAMOND-TYPE SEMICONDUCTORS. Pindor, A. J. (International Centre for Theoretical Physics, Trieste (Italy)). Feb 1972. 19p. INIS.

Two models of covalent crystals—the shell model and the bond charge model—are used to calculate a quadrupole component of valence charge distortion brought about by displacement of an atom from equilibrium position. On the basis of the shell model it appears that sources of the quadrupole extend over a considerable region round the displaced atom. In the extreme case of germanium the radius of the region exceeds four nearest-neighbor distances and there are over 200 atoms within the region. The value of the quadrupole parameter is found to be about four times larger than suggested elsewhere. In the framework of Phillips' bond charge model with variable magnitude of the bond charge, the quadrupole parameter comes out much smaller. It is suggested that this may be due to the fact that in the bond charge model the sources of the quadrupole are limited to the nearest neighborhood of the displaced atom. (auth)

17765 (INP-816) ATOMIC AND MAGNETIC STRUCTURE OF THE $Ni_xCu_{1-x}MnSb$ ALLOYS. Szytula, A. (Institute of Nuclear Physics, Krakow (Poland)). 1972. 22p. Dep. NTIS (U. S. Sales Only) $3.25.

$Ni_xCu_{1-x}MnSb$ alloys (where x varies from 0.05 to 0.4) were studied using neutron-diffraction, x-ray-diffraction, and magnetometric techniques. All the compounds under investigation were found to be of atomic structure of Cl_b type. The complex noncollinear magnetic structure was observed in compounds of compositions $0.05 \leq x \leq 0.4$ at 77 K. $Ni_{0.4}Cu_{0.6}$ MnSb appeared to be a collinear ferromagnetic with the magnetic moment of the Mn atom equal $(3.85 \pm 0.10)\ \mu_B$ at 77 K. (auth)

17766 (IS-T-587) LATTICE DYNAMICS OF GALLIUM ANTIMONIDE. Farr, M. K. (Ames Lab., Iowa). May 1973. Contract W-7405-eng-82. 73p. Dep. NTIS $5.75.

Thesis. Submitted to Iowa State Univ.

The lattice dynamics of gallium antimonide were investigated experimentally using the method of coherent inelastic scattering of thermal neutrons. The frequencies for phonons propagating in three symmetry directions in an undoped gallium antimonide crystal at 300 K were determined with an estimated precision of 2%. (MCW)

17767 (IS-T-592) THERMAL EXPANSION OF SOLID NEON FROM 1 TO 15 K. Holste, J. C. (Ames Lab., Iowa). May 1973. Contract W-7405-eng-82. 85p. Dep. NTIS $6.25.

Thesis. Submitted to Iowa State Univ. of Science and Technology, Ames.

A differential capacitance dilatometer was used to measure thermal expansions from 1.5 to 15K for two sets of free-standing solid-neon samples. These data have been normalized (by 3.6% at most) to agree with accurate x-ray data above 10K to eliminate what are believed to be sample bonding effects. Smoothed values of the thermodynamic properties of solid neon for temperatures up to 23K are used to calculate the Grueneisen parameter γ as a function of temperature. The low-temperature value $\gamma_0 = 2.58 \pm 0.05$ that follows for the present data is uncertain primarily through uncertainties in the bulk modulus. The highest-temperature values of γ can differ by 10% or more, depending on whether recently determined Brillouin scattering or ultrasonic values of the bulk modulus are used. A comparison with the other data suggests that the ultrasonic data may be in error. (auth)

17768 (JINR-E4-7146) ENERGY OF MAGNETIC EXCITATIONS AND MAGNETIZATION IN COMPRESSIBLE FERROMAGNET. Vukajlovic, F. R.; Vlahov, J. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1973. 15p. Dep. NTIS (U. S. Sales Only) $3.00.

An anharmonic ferromagnetic crystal under a constant pressure is considered. The pseudoharmonic approximation for the phonon system and the mean field approximation for the spin system are used. At low temperature an explicit expression for the temperature dependence of the lattice constant and its influence on the magnetic excitation spectrum and magnetization are obtained. (auth)

17769 (JINR-P4-7205) EXACTLY SOLVABLE MODEL WITH INTERACTION OF PARTICLES OF DIFFERENT KINDS. Brankov, I. G.; Shumovskii, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1973. 11p. (In Russian). Dep. NTIS (U. S. Sales Only) $3.00.

Mathematically rigorous proof of existence of the exact (in the thermodynamical limit) solution for a system with interaction of particles of different kinds is given by the example of an Ising antiferromagnet with the interaction J/N between the sublattices. (auth)

17770 (K-Trans-68) THEORETICAL AND EXPERIMENTAL STUDIES ON THE OPERATING CHARACTERISTICS OF A THREE-STAGE AXIAL COMPRESSOR WITH HIGH PER-STAGE PERFORMANCE. Turanskyj, L. 1971. Translated from German. 125p. Dep. NTIS $8.25.

Thesis.

The theoretical studies were performed in the form of a multi-step calculation. In this procedure, the equations for the calculation of the radial equilibrium for a quasi-three-dimensional state of flow were correlated with the cascade characteristics for the individual profile sections from which the blading is developed. This calculation furnishes limits beyond which either local separation of flow or pumping of the compressor may be expected. In the second part of this study, a report is given on the setup of an experimental facility where the experimental studies of the three-stage compressor were performed. In the tests, the state of flow upstream and downstream of the blading was measured at different compressor speeds at different mass rates of flow. A comparison of the results shows that the computing method developed permits a determination of the operating characteristics of high-performance axial compressors. (MOW)

17771 (K-Trans-70) INFLUENCE OF THE RATIO OF AXIAL VELOCITIES UPSTREAM AND DOWNSTREAM OF THE CASCADE ON THE AERODYNAMIC COEFFICIENTS OF A PLANE COMPRESSOR CASCADE. Schlichting, H.; Stark, U. Translated from Rev. Roum. Sci. Tech., Ser. Mecan. Appl.; 17: No. 3, 655-677(1972). 24p. Dep. NTIS $3.25.

Theoretical and experimental investigations on the influence of the axial-velocity ratio on the aerodynamic coefficients of a compressor cascade of NACA 65-(10)06 profiles are described. The Pollard–Horlock method which transforms into the Schlichting procedure in the special case of two-dimensional flow was selected for the theoretical investigations. Experiments were conducted in the low-velocity cascade wind tunnel of the Institute of Fluid Mechanics of Braunschweig Engineering University. The theoretical as well as experimental results show a considerable influence of the axial velocity ratio on the aerodynamic coefficients of the compressor cascade. The agreement between fluid deflection, pressure transformations and pressure distributions found by potential flow theory, and the corresponding experimental values proves to be satisfactory as long as marked separation remains absent. (auth)

17772 (KFKI-73-4) STUDY OF THE KONDO STATE IN AlMn ALLOY BY THERMAL NEUTRON SCATTERING. Kroo, N.; Szentirmay, Zs. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr 1973. 12p. Dep. NTIS (U. S. Sales Only) $3.00.

Neutron scattering studies were performed on Al–0.5% Mn dilute alloy at 80 and 300°K. The incoherent magnetic scattering cross section was measured at the Dubna pulsed reactor as a function of the ingoing neutron energy at four scattering angles. The results are in good agreement with cross sections calculated from the Kondo model. (auth)

17773 (LA-5304-MS) CYLINDRICAL POINT COILS FOR MAGNETIC FIELD MAPPING. Thomason, M. D. (Los Alamos Scientific Lab., N. Mex.). Jun 1973. Contract W-7405-eng-36. 6p. Dep. NTIS $4.00.

The question of an optimum height-to-diameter ratio for field mapping coils is examined. Computer-calculation results are presented for second- and fourth-order errors in the fringe-field region. The effects of the mapping coil size and shape are clearly shown. (auth)

17774 (LA-tr-73-21) PULSE FLUOROMETRY: A NEW FLOW PROCESS FOR ULTRA-QUICK QUANTITATIVE ANALYSIS OF CELL COMPONENTS. Goehde, W.; Dittrich, W. Translated from Acta Histochem., Suppl.; No. 10, 429-437(1971). 13p. Dep. NTIS $3.00.

17775 (LA-UR-73-676) SEQUENTIAL BIOCHEMICAL EVENTS IN PREPARATION FOR DNA REPLICATION AND MITOSIS. Tobey, R. A.; Gurley, L. R.; Hildebrand, C. E.; Ratliff, R. L.; Walters, R. A. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 39p. (CONF-730543-1). Dep. NTIS $4.00.

From monograph on control of proliferation in animal cells conference; Cold Spring Harbor, New York, USA (20 May 1973).

17776 (LA-UR-73-820) NATURE OF HETEROPLOIDY. Kraemer, P. M.; Deaven, L. L.; Crissman, H. A.; Steinkamp, J. A.; Petersen, D. F. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 47p. (CONF-730623-1). Dep. NTIS $4.50.

From symposium on quantitative biology; Cold Spring Harbor, New York, USA (1 Jun 1973).

The phenomenon of heteroploidy seems to us to offer an opportunity to study normal karyotype control by means of defining an instance where that control is defective. Heteroploidy is a chromosomal aberration defined here as an elevated variability of chromosome number and structure. This aberration frequently accompanies malignant cellular growth, but it is emphasized that all of the cellular phenomena that take place in a growing tumor are not discussed; the meaning is restricted to exponentially growing heteroploid cells such as established cell lines in culture. The work described here primarily concerns cellular DNA measurements and chromosomal characteristics of such model systems. (16 figures, 2 tables, 16 references) (auth)

17777 (LA-UR-73-929) HISTONE PHOSPHORYLATION IN G_2 AND MITOSIS. Gurley, L. R.; Walters, R. A.; Tobey, R. A. (Los Alamos Scientific Lab., N. Mex.). 1973. Contract W-7405-eng-36. 15p. (CONF-730443-1). Dep. NTIS $3.00.

From 57th annual meeting of the Federation of American Societies for Experimental Biology; Atlantic City, New Jersey (15 Apr 1973).

17778 (LBL-1181) STRUCTURE, STRENGTH, AND TOUGHNESS OF Fe/Cr/C MARTENSITIC STEELS. McMahon, J. A. (California Univ., Berkeley. Lawrence Berkeley Lab). Jan 1973. Contract W-7405-eng-48. 63p. Dep. NTIS $5.25.

Thesis.

The changes in microstructure and mechanical properties of Fe/Cr/C martensitic steels as functions of chromium and carbon content were investigated using transmission electron microscopy and tensile, compressive, and fracture toughness testing. The as-quenched martensitic microstructures and the carbide morphologies produced by tempering at 200, 400, and 600°C were analyzed. For a given carbon content, the volume fraction of martensite containing transformation twins increased with chromium concentration, demonstrating that chromium induces transformation twinning in martensite. M_s temperature measurements showed that increasing the chromium level also lowers the M_s temperature, and as expected the amount of autotempering during quenching decreased. (MCW)

17779 (LBL-1495) THERMODYNAMICS OF SOLID-STATE SINTERING. Hoge, C. E.; Pask, J. A. (California Univ., Berkeley. Lawrence Berkeley Lab). Mar 1973. Contract W-7405-eng-48. 32p. (CONF-730905-1). Dep. NTIS $3.75.

From third international round table meeting on sintering; Heroeg Novi, Yugoslavia (3 Sep 1973).

A thermodynamic analysis of solid-state sintering of a single-phase isotropic material of uniform particle size indicates that the ratio of the solid/solid and solid/vapor interfacial energies (γ_{ss}/γ_{sv}) is critical; in order to realize theoretical density it must be smaller for less dense packings of unfired compacts. Another critical requirement is that pores must remain on grain boundaries during sintering. Pores on planar grain boundaries are effectively pinned. Curved grain boundaries can break away from pores when they achieve critical curvatures; this feature is essentially independent of γ_{ss}/γ_{sv} or the corresponding dihedral angle in the normal range of values. Nonuniform particle or grain-size distribution thus must be avoided since they lead to grain-boundary curvatures. (auth)

17780 (LBL-2015) USE OF AROMATIC RESIDUES TO PROBE THE IRON–SULFUR CLUSTERS OF CLOSTRIDIUM ACIDI-URICI AND CLOSTRIDIUM PASTEURIANUM FERREDOXINS. Packer, E. L. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1973. Contract W-7405-eng-48. 401p. Dep. NTIS $22.25.

Thesis.

17781 (LFEN-150-a) ATOMIC PROCESSES IN A POSITIVE COLUMN OF MERCURY VAPOR. Determination of Some Parameters. Teixeira, M. R. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1973. 39p. (In Portuguese). Dep. NTIS (U. S. Sales Only) $4.00.

17782 (MLM-1940) FLUIDIC NONCONTACT GAGING. Schurman, W. R.; Coons, G. L. (Mound Lab., Miamisburg, Ohio). 15 Jun 1973. Contract AT-33-1-Gen-53. 24p. Dep. NTIS $4.00.

A fluidic noncontact method of gaging using low-pressure air (less than 1 psig) was developed for measuring compacted powder heights of loaded detonators. Conventional air gages which used air flow indicators and back-pressure sensors were investigated; however, the minimum recommended operating pressure of 5 psig for gages of this type would disturb the compacted powder surfaces. A gaging system employing extremely low back pressures coupled with a fluidic logic network was built and evaluated. Maximum sensing pressure and optimum gaging distance were established. Tooling for gaging the compacted powder heights for two different loaded detonators was developed. The relationship of back pressure and powder heights was determined over an 0.008 in. range. The fluidic gage was outfitted with air-operated indicator lights to indicate parts which were in tolerance, above tolerance, or below tolerance. The gage was also outfitted with a precision bourdon tube graduated in 0.005 psig divisions for obtaining actual back pressure readings. Other applications which could take advantage of gaging and sensing at extremely low pressures as they apply to detonator fabrication were also investigated. A complete survey of the operation of three different fluidic devices was also completed. (auth)

17783 (MLM-2050) FABRICATION OF SMALL METAL SPHERES. Wittenberg, L. J.; Fleming, D. L. (Mound Lab., Miamisburg, Ohio). 31 May 1973. Contract AT(33-1)-Gen-53. 5p. Dep. NTIS $4.00.

A technique based upon the rapid shearing of a liquid-metal stream was developed for the formation of uniform-size metal spheres. In one test of the method with liquid lead, nearly 90 wt. % of the spheres were in the predicted size range of 600 ± 240 μm. (auth)

17784 (NP-19796) QUANTUM THEORY OF rf RESONANCES: THE SEMICLASSICAL LIMIT. Stenholm, S. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). 1973. 33p. Dep. NTIS (U. S. Sales Only) $3.75.

It is shown that, in contradiction with work by Chang and Stehle, the semiclassical description of rf-resonance experiments is valid. The density matrix equation of motion is set up for a two-level atom interacting with a one-mode quantized field. The terms giving the semiclassical description are separated and the contributions arising from the rest are carefully evaluated. Corrections to the semiclassical treatment are found to be of order $\bar{n}_0^{-2}$, where n_0 is the average number of rf photons. In practice such corrections are negligible. (auth)

17785 (ORAU-119) CODING INDEX FOR TUMOR SCANNING. Kniseley, R. M. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). 1973. 6p. Dep. NTIS $4.00.

17786 (ORNL-4893) DYNAMICS OF LITTER DECOMPOSITION, MICROBIOTA POPULATIONS, AND NUTRIENT MOVEMENT FOLLOWING NITROGEN AND PHOSPHORUS ADDITIONS TO A DECIDUOUS FOREST STAND. Kelly, J. M. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-26. 214p. Dep. NTIS $7.60.

Thesis. Submitted to Univ. of Tennessee.

17787 (ORNL-EIS-73-16) ARSENIC IN THE ENVIRONMENT. An Annotated Bibliography. Copenhaver, E. D.; Ulrikson, G. U.; Newman, L. T.; Van Hook, R. I. Jr. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 304p. Dep. NTIS $17.25.

17788 (ORNL-NSF-EP-42) MATERIAL RESOURCES AND RECYCLING. Report of Progress, January 1, 1971–June 15, 1972. 1972. (Oak Ridge National Lab., Tenn.). Jul 1973. Contract W-7405-eng-26. 136p. Dep. NTIS $9.00.

The activities of the Material Resources and Recycling (MRR) Team of the NSF-supported Environmental Program at Oak Ridge National Laboratory are described. One part of the work involves the assessment of materials management problems such as the long-term availability of non-fuel, nonrenewable resources; the energy expenditures for extracting metals from lower grade ores and for recycling; the land use conflicts associated with forest management; and the control of toxic metals, especially mercury and cadmium. A second part of the work includes laboratory experiments to investigate the movement of cadmium and mercury in aquatic and terrestrial ecosystems with some focus on the chemistry of these elements in the soil and sediment sinks. In addition, a high sensitivity x-ray fluorescence method is being developed for detecting heavy elements using hot-pressed pyrolytic graphite monochromators to reduce background interference. The third part of MRR activities involves waste management studies and these comprise (1) the application of dynamic membrane hyperfiltration (reverse osmosis) and other advanced techniques to the treatment of industrial waste streams such as Kraft paper mill bleaching wastes, textile dyeing mill wastes and aqueous wastes containing toxic elements, and (2) feasibility planning on a regional solid waste management system featuring recycling and waste utilization (Wasteplex) for a 29-county area in East Tennessee and North Georgia. Finally, the MRR Team is contributing to the development of data bases for the Environmental Information System of the ORNL–NSF Environmental Program, especially in the areas of toxic materials and waste management. (auth)

17789 (ORNL-tr-2602) OPTIMAL CONDITIONS OF EXCITATION IN LASER MICROSCOPIC SPECTRAL ANALYSIS WITH FOREIGN-BODY IGNITION OF THE AUXILIARY SPARK EXCITATION. Quilfeldt, W. Translated by R. G. Mansfield from Exp. Tech. Phys.; 17: No. 5-6, 415-429(1969). 19p. Dep. NTIS $3.00.

In connection with the use of the commercial Carl Zeiss laser microspectral analyzer LMA 1 to study conditions of excitation with simultaneously extended range of application, the auxiliary spark excitation was triggered by foreign body ignition. The parameters of the auxiliary spark discharge were changed separately and an attempt made to find optimal adjustments. Thereby it was shown that an electrode spacing of 1 mm, an excitation energy of 40 Ws with a capacity of 2.5 μF and an inductivity of 125 μH are optimal. The instant of beginning of the auxiliary spark discharge for attaining the greatest spectral intensity varies between a time difference of 0 μ s between it and the laser pulse with easily vaporized substances and 60 μ s with difficultly vaporizable ones. A high voltage with a small capacity proves to be advantageous as compared to low voltage at large capacity. Two processes of protecting the surface of the specimen while working with high-energy sparks are presented. (auth)

17790 (ORNL-tr-2639) INTERPRETATION OF ABNORMAL SCATTERING OF X RAYS BY AGE-HARDENING ALLOYS. Guinier, A. Translated by R. G. Mansfield from Acta Crystallogr.; 5: 121-129(1952). 32p. Dep. NTIS $3.75.

17791 (ORNL-tr-2691) SOME LAWS GOVERNING THE EFFECT OF PRELOADING UNDER ALTERNATING TENSILE STRESSES ON THE CREEP STRENGTH OF Cr-18Ni-10Ti STEEL. Lyutii, E. M.; Maksimovich, G. G.; Pagirnii, S. V. Translated from Fiz.-Khim. Mekh. Mater.; 8: No. 4, 32-35(1972). 6p. Dep. NTIS $3.00.

17792 (ORNL-tr-2692) SPECIFIC CHARACTERISTICS OF CRACK PROPAGATION DURING CYCLIC LOADING IN LIQUID MEDIA. Romanov, O. N.; Petrina, Yu. D.; Zima, Yu. V. Translated from Fiz.-Khim. Mekh. Mater.; 8: No. 4, 35-38(1972). 7p. Dep. NTIS $3.00.

The effects of various media (air, oil, water, 3% oleic acid in mineral oil) were studied at 300, 400, and 550°C for high-strength 50 CrNi steel. The number of cycles necessary to form a circular crack 1 mm deep was measured, and the effects of cold work and aging were estimated from the ultimate strength in air. Microstructure and fracture structure are discussed. (DLC)

17793 (ORO-3800-8) CONDUCTION ELECTRONS AND MAGNETISM. Final Report, May 1, 1968-April 30, 1972. Anderson, J. R.; Bhagat, S. M. (Maryland Univ., College Park). 1972. Contract AT(40-1)-3800. 16p. Dep. NTIS $3.00.

Relaxation of long-wavelength spin waves was studied in Fe, Ni, hcp Co, and Ni-Cu by investigating the resonant absorption of microwaves (FMR), and information was obtained on the electronic structure of hcp Co using the de Haas-van Alphen effect. (DLC)

17794 (ORO-4254-9) COMPARTMENTED AQUATIC MODEL OF THE RELATIONSHIP BETWEEN CARBONATE AND NITRATE IN A GREAT PLAINS RESERVOIR. Varga, L. P.; Rice, G. K.; Toetz, D. W.; Loughran, E. D. (Oklahoma State Univ., Stillwater; Los Alamos Scientific Lab., N. Mex.). 1973. Contract AT(40-1)-4254. 23p. (CONF-730445-1). Dep. NTIS $3.25.

17795 (ORO-4310-2) PHYCOBILIPROTEIN CHARACTERISTICS AND MEMBRANE ASSOCIATION. Progress Report, October 15, 1972-October 14, 1973. Gantt, E. (Smithsonian Institution, Washington, D. C. Radiation Biology Lab.). 1973. Contract AT(40-1)-4310. 10p. Dep. NTIS $3.00.

17796 (RISO-279) AUTOMATIC LOW-TEMPERATURE SYSTEM FOR NEUTRON FOUR-CIRCLE DIFFRACTOMETER. Merisalo, M.; Nielsen, M. H.; Henriksen, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1973. 14p. Dep. NTIS (U.S. Sales Only) $3.00.

17797 (RLO-2225-T-24-9) PLANKTONIC FORAMINIFERAN: RADIOLARIAN STRATIGRAPHY AND THE PLEISTOCENE-HOLOCENE BOUNDARY IN THE NORTHEAST PACIFIC. Barnard, W. D.; McManus, D. A. (Washington Univ., Seattle. Dept. of Oceanography). 1972. 10p. Dep. NTIS $3.00.

17798 (RLO-2225-T-26-10) BENTHIC COMMUNITY METABOLISM ON THE CONTINENTAL TERRACE AND IN THE DEEP SEA IN THE NORTH PACIFIC. Pamatmat, M. M. (Washington Univ., Seattle. Dept. of Oceanography). 1972. 50p. Dep. NTIS $4.50.

The rates of total oxygen uptake, residual oxygen consumption after poisoning with formaldehyde, and respiration of undisturbed sediment cores from the continental terrace, the abyssal plains, and the Aleutian Trench of the North Pacific were measured aboard ship. These measurements, together with determinations of organic carbon, sand, silt, and clay content, of concentrations of reduced substances, and of dissolved oxygen and nutrient salts in interstitial and overlying bottom water, give indications of the relative level of community metabolism, both aerobic and anaerobic, in the different study areas. (auth)

17799 (RLO-2230-T-2-10) DIFFUSION CONTROLLED REACTIONS AND EXCHANGE REACTIONS IN SOLUTION. Annual Progress Report. Noyes, R. M. (Oregon Univ., Eugene). 29 May 1973. Contract AT(45-1)-2230. 18p. Dep. NTIS $3.00.

17800 (RT/FI-(73)7) ACCURACY OF EXPERIMENTAL DATA AND SIGNIFICANCE OF THE RESULTS. Agostinelli, M'; Pompa, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 8 Feb 1973. 74p. (In Italian). (CONF-710987-1). Dep. NTIS (U. S. Sales Only) $5.75.

One problem to solve in x-ray diffractometry is the estimation of the accuracy of the integrated intensity measurements, which is proportional to the square of the structure factor. The main sources of experimental errors are defined, their magnitude evaluated, and possible procedures that minimize their effects are formulated. Particular emphasis is given to the control of EHT, amplification, and discrimination variables, and to the fixed-time and fixed-count methods for collecting intensities. (auth)

17801 (SCL-DC-720218) EFFECTS OF RADIATIVE HEAT TRANSFER UPON THE MELTING AND SOLIDIFICATION OF SEMI-TRANSPARENT CRYSTALS. Abrams, M.; Viskanta, R. (Sandia Labs., Livermore, Calif.). Feb 1973. Contract AT(29-1)-789. 41p. (CONF-730803-1). Dep. NTIS $4.25.

Thesis. Submitted by M. Abrams to Purdue Univ., Lafayette, Ind.

Employing the assumptions of one-dimensional energy transfer, equilibrium phase change, and negligible convection in liquid regions, the time-dependent conservation of energy equation is formulated for the general situation of n semi-transparent contiguous liquid and solid phases. Spectral optical properties of the media are modeled by band and gray approximations. The dimensionless parameters governing the problem are identified, and the effects of their variation are ascertained by a finite-difference solution of the rigorously formulated energy and radiative transfer equations. The chief conclusions of this investigation are that for the range of parameters encountered in the melting and solidification of many optical materials, radiant transfer has a significant effect, and that during solidification, radiation can force the temperature profile within the liquid phase to assume a shape that leads to unstable interfacial growth. (auth)

17802 (SGAE-2092) MAGNETIC FORM FACTORS OF Ni-Fe ALLOYS. Dobrzynski, L.; Eder, O. J.; Maniawski, F.; Modrzejewski, A.; Rossmanith, E.; Sikorska, D. (Oesterreichische Studiengesellschaft fuer Atomenergie G.M.B.H., Seibersdorf. Physik-Institut). Feb 1973. 27p. Dep. NTIS (U. S. Sales Only) $3.50.

Magnetic form factors of three Ni-Fe alloys (14, 21, and 50 at. % Fe) were measured by means of polarized-neutron diffraction. A comparison of the alloy form factors with the form factor of Ni is performed, and the asphericity, the spin density, and the changes in the symmetry of the spin density are discussed. Results for electronic-structure parameters from a comparison of experimental and theoretical form factors are presented. (auth)

17803 (SLA-73-30) FORMULATION OF THE THREE-DIMENSIONAL HYPERSONIC VISCOUS SHOCK-LAYER PROBLEM. Part I. Governing Equations and Geometrical Formulas. Moreno, J. B. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 57p. Dep. NTIS $3.00.

The governing equations, associated boundary conditions, and formulas for heat transfer and skin friction for the three-dimensional hypersonic viscous shock-layer problem are formulated. The calculation of an orthogonal curvilinear coordinate mesh for the problem is treated, and formulas for the related metric coefficients are derived. Finally, the necessary geometrical relations for handling the shock-wave calculation are presented. (auth)

17804 (SLA-73-423) MODELING THE SOFAR CHANNEL IN THE OCEAN WITH A GAS WAVEGUIDE. Hardee, H. C.; Sullivan, W. N. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 32p. Dep. NTIS $3.00.

A series of experiments performed with a gas waveguide to model low-frequency, long-range reverberations in the SOFAR deep sound channel in the ocean is described. (auth)

17805 (SLA-73-429) CALIBRATION TECHNIQUES AND COMPUTER CODES FOR AUTOMATED LARGE-SIGNAL MICROWAVE S-PARAMETER MEASUREMENTS. Chaffin, R. J.; Leighton, W. H. (Sandia Labs., Albuquerque, N. Mex.). May 1973. 28p. Dep. NTIS $3.50.

Improved calibration and data reduction techniques for large-signal microwave S-parameter measurements are described. Data acquisition and reduction are accomplished by use of the Sandia PDP-10 time-sharing computer in conjunction with the S-parameter test set. Elimination of systematic errors that are not eliminated by usual calibration methods is accomplished by means of improved calibration and data-reduction techniques. Microwave S parameters in the 10-MHz to 1-GHz frequency range can be measured with an accuracy of ±0.01 in magnitude and ±1° in angle with this system at power levels up to 50 W. (auth)

17806 (SLA-73-535) FACTORS THAT AFFECT THE SOLID-PHASE BONDING OF GOLD-WIRE ELECTRICAL LEADS. Cuthrell, R. E.; Tipping, D. W. (Sandia Labs., Albuquerque, N. Mex.). May 1973. 24p. Dep. NTIS $3.25.

The results are reported of a study of the factors which affect the solid-phase bonding of gold wire electrical leads. Gold surfaces were cleaned by sputtering and joined with precise control of mechanical and environmental variables. Contact resistance measurements as a function of load, coefficients of adhesion, and laser interference fringe photomicrotopographs were used as diagnostics to show the effects of cleaning, annealing, loading, and creep. Ultrahigh-vacuum techniques and vibration isolation were essential to reproducibly forming and measuring the strengths of solid-phase bonds between gold samples and between gold and tungsten. (auth)

17807 (SLA-73-665) AC AND DC ELECTRICAL CHARACTERISTICS OF POLYTHERMALEZE-200 POLYIMIDE WIRE INSULATION INCLUDING EFFECTS OF POTTING IN EPON-828. Pike, G. E.; Seager, C. H. (Sandia Labs., Albuquerque, N. Mex.). Jun 1973. 19p. Dep. NTIS $3.00.

17808 (SLA-73-5049) FRACTURE AND STRAIN ENERGY RELEASE IN PRESTRESSED GLASS AND GLASS-CERAMICS. Beauchamp, E. K. (Sandia Labs., Albuquerque, N. Mex.). 1973. 11p. (CONF-730707-1). Dep. NTIS $3.00.

Efforts to characterize commercially available frangibles in terms of stored strain energy and energy released in dicing are described. A model for the generation of a secondary fracture, which is essential to the dicing process, is also described. (auth)

17809 (SLA-73-5452) GENERALIZED ABLATIVE FLOW IN GAPS AND SLOTS. Cooper, L.; Putz, K. E. (Aerotherm Corp., Mountain View, Calif.; Sandia Labs., Albuquerque, N. Mex.). 1972. 12p. (CONF-730716-1). Dep. NTIS $3.00.

From 8th thermophysics conference; Palm Springs, California, USA (16 Jul 1973).

An analytical method of predicting the flow properties in gap regions about control surfaces of reentry vehicles was developed. The method is particularly applicable to situations involving regions containing ablating surfaces. The analysis is based on a quasi-one-dimensional compressible flow solution including the effects of area change, friction, heat transfer, mass addition, and shocks. The effects of wall roughness and boundary layer transition effects also are included. The solution technique consists of a finite-difference approximation to the equations of change. (MOW)

17810 (SLA-73-5530) SHORTCUTS IN HUMAN RELIABILITY ANALYSIS. Swain, A. D. (Sandia Labs., Albuquerque, N. Mex.). 1972. 28p. (CONF-730714-1). Dep. NTIS $3.50.

From Generic techniques in systems reliability assessment conference; Liverpool, UK (16 Jul 1973).

Several techniques for making qualitative or quantitative estimates of the likelihood that human tasks will be performed incorrectly are discussed. These techniques involve the use of judgments by subject-matter experts, ranging from the analyst himself to performers of tasks. The techniques are based on the human reliability model and methodology used by ergonomists at Sandia Laboratories. (auth)

17811 (SLA-73-5597) APPLICATIONS OF PHOTON STATISTICS AND PHOTON CORRELATION. Schaefer, D. W. (Sandia Labs., Albuquerque, N. Mex.). 1973. 43p. (CONF-730712-1). Dep. NTIS $4.25.

Recent work has extended photon counting methods to a wide range of scientific and engineering applications. This review concentrates on applications in the areas of physics and biology with emphasis on light scattering from macromolecular solutions. The experiments described involve the characterization of I(t), the fluctuating light intensity scattered from a macroscopically homogeneous sample which scatters light due to random microscopic refractive index inhomogeneities. Because of the stochastic nature of the scattering phenomena, intensity fluctuations must be described in a statistical way, i.e., through amplitude probability distributions and time correlation functions (or equivalently, power spectra). (MOW)

17812 (SLL-73-7) DEVELOPMENT OF POROUS STAINLESS-STEEL FLOW CONTROL DEVICES. Lindsay, P. B. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 47p. Dep. NTIS $4.00.

A one-step hot-isostatic pressing (HIP) of spherical stainless-steel powder produced flow control devices with flow rates down to 10^{-4} STD cc/s helium. A post-HIP secondary deformation with either a hemispherical or flat-face punch reduced the flow rate of these devices to 10^{-7} cc/s. Both the HIP and secondary processes are considered as viable production methods. (auth)

17813 (SLL-73-15) EFFECT OF RESIDUAL INPLANE STRESS IN THE TARGET RESULTING FROM FLYER-TARGET IMPACT. Birnbaum, M. R.; Murphy, L. M. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 36p. Dep. NTIS $4.00.

When impulse loading of structures is simulated by flyer plate techniques, the residual inplane stresses and the induced initial velocity of the target act as forcing functions for subsequent structural motion. Structural response calculations demonstrate that deformations caused by such stresses are nearly always negligible in comparison with those caused by the induced initial velocities. (auth)

17814 (SLL-73-244) MODEL FOR DESCRIBING DIFFUSION BEHAVIOR OF Na_2O-SiO_2 GLASS BY A TWO-PHASE DIFFUSION MODEL. Keeton, S. C. (Sandia Labs., Livermore, Calif.). Jun 1973. Contract AT(29-1)-789. 33p. Dep. NTIS $3.75.

An idealized two-phase model is developed to describe the helium permeation and diffusion behavior in two phase glasses. Theoretical Fick's Law calculations are performed to verify the model. Analytical expressions are produced for a one-dimensional treatment that approximates the exact Fick's Law solutions for the model. These analyses are supplemented by numerical two-dimensional calculations that treat the helium diffusion properly. The two-phase model proposed appears to describe satisfactorily Shelby's experimental helium permeability and diffusivity in two-phase Na_2O-SiO_2 glass. (auth)

17815 (SRO-735-2) STUDIES ON MECHANISMS OF MUTATION, RECOMBINATION AND GENE ACTION IN NEUROSPORA. Progress Report, October 1, 1972–September 30, 1973. Giles, N. H. (Georgia Univ., Athens. Dept. of Zoology). 30 Jun 1973. Contract AT(38-1)-735. 41p. Dep. NTIS $4.25.

17816 (SU-326-P-33-X-2) EVOLUTION OF SURNAMES: AN ANALYSIS OF THEIR DISTRIBUTION AND EXTINCTION. Yasuda, N.; Cavalli-Sforza, L. L.; Skolnick, M.; Moroni, A. (Stanford Univ., Calif.). 1972. Contract AT(04-3)-326. 27p. Dep. NTIS $3.50.

17817 (TID-26355) THERMAL NEUTRON SCATTERING ON MAGNETIC MATERIALS AND LIQUIDS. Nathans, R. (State Univ. of New York, Stony Brook). 1972. Contract AT(30-1)-4084. 8p. Dep. NTIS $3.00.

Highlights of two and a half years of research on the subject are reported very briefly. (LMT)

17818 (TID-26360) INTERRELATIONSHIP BETWEEN CERTAIN HYDROGRAPHIC FEATURES ASSOCIATED WITH CURRENTS AND PRIMARY PRODUCTION. Progress Report, September 1, 1972–August 31, 1973. Yentsch, C. S. (Massachusetts Univ., Gloucester. Marine Station). 1973. Contract AT(11-1)-3024. 7p. Dep. NTIS $3.00.

17819 (UCID-16238) SYSTEMS SAFETY ANALYSIS AND FAULT TREE ANALYSIS. Lambert, H. E. (California Univ., Livermore. Lawrence Livermore Lab.). 9 May 1973. Contract W-7405-eng-48. 74p. Dep. NTIS $5.75.

Systems safety analysis is a systematic process of identifying hazardous conditions existing in a system. The two principal methods of safety analysis are inductive and deductive analysis. Inductive techniques include preliminary hazards analysis, failure modes and effects and criticality analysis, fault hazards analysis, decision trees, and Markovian processes. They are best applied to generic equipment hazards. On the other hand, the development of subsystem functional faults requires deductive analysis, specifically fault tree analysis. The fault tree is a graphic and logical representation of the various combinations of possible events, both fault and normal, occurring in a system. These events are

represented by the appropriate symbols that can be used as inputs and/or outputs of the standard AND and OR gates or other special gates. The fault tree is built by construction rules that establish the procedures necessary at each gate to determine the type of gate to use and the inputs to the gate. Fault tree evaluation can be both qualitative and quantitative. The safety program is the culmination of all the analysis techniques and insures that an adequate level of safety is achieved in the final design of the system. (auth)

17820 (UCID-16269) MICROSTRUCTURE CHARACTERIZATION OF AN ORGANIC FIBER. Hanafee, J. E. (California Univ., Livermore. Lawrence Livermore Lab.). 25 May 1973. Contract W-7405-Eng-48. 14p. Dep. NTIS $3.00.

Characterization of the failure mode of an organic fiber, PRD-49-III, was carried out utilizing transmission and scanning electron microscopy and optical microscopy. Fracture surfaces of (1) bare fibers, (2) epoxy-impregnated strands from tensile tests, (3) pressure vessels, and (4) NOL rings were compared. The mode of fiber failure was splitting along the fiber axis, and was apparently accompanied by a necking down of individual components of the fiber. (auth)

17821 (UCRL-51374) KINETICS OF EXCIMER FORMATION IN RARE GASES. Viecelli, J. A. (California Univ., Livermore. Lawrence Livermore Lab.). 12 Mar 1973. Contract W-7405-eng-48. 12p. Dep. NTIS $4.00.

17822 (UCRL-51380) REVIEW OF FRACTURE TOUGHNESS METHODS. Prado, M. E. (California Univ., Livermore. Lawrence Livermore Lab.). 25 Apr 1973. Contract W-7405-eng-48. 19p. Dep. NTIS $4.00.

The areas of fracture-safe design and linear fracture mechanics are discussed. The relationship of these two approaches to toughness evaluation is described. Interpretation of fracture toughness tests in terms of design requirements is presented. A discussion is given on the applicability of the tests commonly used, their present interpretation, and the areas where the validity of the tests is questionable. (14 references) (auth)

17823 (UCRL-73867) SHOCK-WAVE STUDIES OF ICE AND TWO FROZEN SOILS. Larson, D. B.; Bearson, G. D.; Taylor, J. R. (California Univ., Livermore. Lawrence Livermore Lab.). 4 Oct 1972. 34p. (CONF-730708-1). Dep. NTIS $3.75.

Shock-wave experimental techniques were used to determine the high-strain-rate equation-of-state for ice and for two fully-saturated frozen soils. Two different loading techniques were used. In each technique, thin foils of brass were sandwiched between the frozen material. Material-velocity as a function of time was determined by monitoring the emf induced in these foils as they moved through an external magnetic field. These data were then used in conjunction with one-dimensional numerical simulational models as a means of establishing an equation-of-state description. (MOW)

17824 (UCRL-Trans-10699) KINETICS OF TWO-STEP SELECTIVE PHOTODISSOCIATION OF MOLECULES BY LASER RADIATION. Letokhov, V. S.; Makarov, A. A. 1972. Translation of Russian Preprint No. 2. 34p. Dep. NTIS $3.75.

A method of two-step photodissociation of molecules by laser radiation for selective cleavage of bonds in the molecules is discussed. The essence of this method is that the substance is irradiated with two laser pulses of different frequencies. One radiation, of frequency ω_1, is in resonance with the vibrational–rotational transition of the molecules and produces vibrational excitation. The second radiation, of frequency ω_2, brings about photodissociation of the vibrationally excited molecules, but its energy is insufficient for this purpose if the molecules have not been excited. In practice the first radiation should be in the infrared region and the second in the ultraviolet. An analysis is carried out. (MOW)

17825 (UR-3055-6) APPLICATION OF THE ELECTRON PROBE MICROANALYZER TO THE QUANTITATIVE ANALYSIS OF BIOLOGICAL MATERIAL AND THE ANALYSIS OF INTESTINAL CALCIUM TRANSPORT. Warner, R. R. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 398p. Dep. NTIS $22.00.

Thesis.

17826 (UR-3490-172) CYLINDRICAL AEROSOL SPECTROMETER. Tillery, M. I. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1972. 77p. Dep. NTIS $6.00.

Thesis.

A cylindrical aerosol spectrometer utilizing centrifugal sedimentation to separate the particles is described. The spectrometer utilizes a new type of inlet system that permits introduction of the sample into the deposition channel through a short inlet from an excess of dusty air. Calibration curves for several rotational speeds and deposition channel flow rates are given. The inlet losses and the resolution of the instrument are discussed. (auth)

17827 (UR-3490-291) STRUCTURE AND FUNCTION OF THE RED CELL MEMBRANE: CHANGES DURING STORAGE. Weed, R. I.; LaCelle, P. L.; Udkow, M. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1973. 28p. (CONF-730549-1). Dep. NTIS $3.50.

17828 (UR-3490-292) SODIUM AND POTASSIUM CONTENT OF SINGLE CELLS: EFFECTS OF METABOLIC AND STRUCTURAL CHANGES. Barrett, E. J.; Coleman, J. R. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1973. 4p. (CONF-730809-2). Dep. NTIS $3.00.

From 8th national conference on electron probe analysis; New Orleans, Louisiana, USA (13 Aug 1973).

17829 (UR-3490-299) ELECTRON-PROBE ANALYSIS OF CALCIUM CONTAINING LIPID DROPLETS IN TETRAHYMENA PYRIFORMIS. Coleman, J. R. (Rochester Univ., N. Y. School of Medicine and Dentistry). [nd]. 4p. (CONF-730809-3). Dep. NTIS $3.00.

From 8th national conference on electron probe analysis; New Orleans, Louisiana, USA (13 Aug 1973).

17830 (Y-1885) CONTACT TOOL SETTER. Greene, L. M. (Oak Ridge Y-12 Plant, Tenn. (USA)). 9 Jul 1973. Contract W-7405-eng-26. 16p. Dep. NTIS $4.00.

In an effort to improve the precision of machined parts, a method was sought for improving the tool-setting operation for numerically controlled turning machines. By taking advantage of the submicrometer resolution of state-of-the-art numerical control, a low-pressure contact tool setter was developed that had a resolution of ±10 microinches (±0.254 μm). The tool setter was designed to be incorporated into numerically controlled turning machines using machine tool reference-point operations and automatic tool-setting control. (auth)

17831 (Y-IA-119) PREVENTIVE MAINTENANCE SYSTEMS AT THE Y-12 PLANT. Bryson, J. K.; Gentry, D. H. (Oak Ridge Y-12 Plant, Tenn. (USA)). 2 May 1973. Contract W-7405-eng-26. 27p. (CONF-730620-1). Dep. NTIS $3.50.

From course in maintenance management meeting; Atlanta, Georgia, USA (18 Jun 1973).

The following topics are briefly described: (1) maintenance organization, (2) work control program, (3) equipment maintenance program, (4) instrument certification program, (5) lubrication program, and (6) equipment repair history. (MOW)

17832 (Y-JA-94) EXTINGUISHMENT OF WOOL BAG FILTER FIRES USING HALON 1301. DeMonbrun, J. R.; McCormick, J. W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 13 Jun 1973. Contract W-7405-eng-26. 11p. Dep. NTIS $3.00.
7405-eng-26. 11p. Dep. NTIS $3.00.

Wool filter bags in a baghouse can be sufficiently heated and ignited by a duct fire during full airflow. Detection of heat rise during full airflow occurs well in advance of flashover. The proposed system of rate-of-rise heat detection will prevent exposure of the bags to high temperature for an appreciable period of time. A fully involved baghouse can be extinguished with Halon 1301 once containment is achieved. (auth)

17833 TORQUE WRENCH TOOLS OF MACHINE DESIGN (ENGINEERING MATERIALS). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2347).

6 Drawings.

17834 ELECTRON BEAM INITIATED CO_2 LASER AMPLIFIER (30 MAR 1972) (ENGINEERING MATERIALS). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2350).

12 drawings.

17835 POSITION INTERPRETER LOGIC, CLOSED CIRCUIT TV. II. (30 May 1973) (Engineering Materials). (California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2355).

5 drawings.

17836 SPACE VEHICLE. Frederick, C. O. (to British Railways Board). British Patent 1,310,990. 21 Mar 1973. Filed date 11 Dec 1970. 4p.

The space vehicle described consists of a platform, with a thermonuclear fusion zone at the underside of the platform, means for supplying fusion material to this zone, and one or more lasers to provide ignition for the fusion material. Magnetic means are provided to deflect charged particles emitted from the fusion zone, together with a number of electrodes to receive these particles and thereby provide a source of electrical power. An electric generator is provided to supply power to initiate operation of the lasers. Thermal energy absorbing means are provided adjacent to the fusion zone, the absorbed energy being transmitted to and radiated from the upper surface of the platform. Servo-controlled means are provided to control the inclination of the platform. (UK)

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